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American Association of Petroleum Geologists, Bulletin. Tulsa, Oklahoma.
American Ceramic Society, Journal. Easton, Pennsylvania.
Arizona Highways. Phoenix, Arizona.
Canada, Directorate of Scientific Information Service, Defence Research Board, [Translations]. Ottawa.
Canada, Geological Survey, Paper. Ottawa.
Carleton University, Dept. of Geology, Geological Paper. Ottawa.
Colorado School of Mines, Mineral Industries Bulletin. Golden, Colorado.
Economic Geology (Society of Economic Geologists). Lancaster, Pennsylvania.
Florida Geological Survey, Information Circular. Tallahassee, Florida.
Florida State Museum, Bulletin, Biological Sciences. Gainesville, Florida.
Geochimica et Cosmochimica Acta. London-New York.
International Geology Review (American Geological Institute). Washington, D. C.
Journal of Mammalogy. Lawrence, Kansas.
Journal of Paleontology. Tulsa, Oklahoma.
Kansas, State Geological Survey, Bulletin. Lawrence, Kansas.
Lapidary Journal. Del Mar, California.
Mines Magazine (Colorado School of Mines, Alumni Association). Denver, Colorado.
Mining Congress Journal. Washington, D. C.
National Research Council, Highway Research Board, Bulletin. Washington, D. C.
New Mexico, Bureau of Mines and Mineral Resources, Bulletin. Socorro, New Mexico.
New York Academy of Sciences, Transactions. New York.
Ohio Journal of Science. Columbus, Ohio.
Oil and Gas Journal. Tulsa, Oklahoma.
Ontario Dept. of Mines, Annual Report. Toronto.
Plateau (Northern Arizona Society of Science and Art, Inc.). Flagstaff, Arizona.
Quebec (Province), Dept. of Mines, Geological Report; Preliminary Report. Quebec.
Rocks and Minerals. Peekskill, New York.
Science. Washington, D. C.
Smithsonian Institution, Smithsonian Miscellaneous Collections. Washington, D. C.
Texas, University, Bureau of Economic Geology, Report of Investigations. Austin, Texas.
U. S. Atomic Energy Commission, [Publication]. Oak Ridge, Tennessee.
U. S. Geological Survey, Bulletin; Geophysical Investigations Map; Mineral Investigations Map; Miscellaneou Investigations; Oil and Gas Investigations Map; Professional Paper. Washington, D. C.
Virginia Minerals (Virginia, Dept. of Conservation and Development, Division of Geology). Charlottesville Virginia.
Virginia Polytechnic Institute, Bulletin; Engineering Experiment Station Series. Blacksburg, Virginia.
Western Miner and Oil Review. Vancouver, British Columbia.

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Those wishing to purchase items abstracted herein should address their orders to the agency, society, organization indicated in the bibliographic citations preceding the abstracts, or to their local book dealer. The city and state for the serials cited are given above. The American Geological Institute, publisher of GeoScience Abstracts, regrets that it cannot fill purchase orders for abstracted publications other than its own.

GeoScience Abstracts

1. GEOLOGIC MAPS, AREAL AND REGIONAL GEOLOGY

PART 1. GEOLOGIC MAPS

1040. Welch, Stewart W. **MISSISSIPPIAN ROCKS F THE NORTHERN PART OF THE BLACK WAR-OR BASIN, ALABAMA AND MISSISSIPPI:** U.S. ol. Survey, Oil & Gas Inv. Map OC-62, index map, secs., chart, 1959, pub. 1960.

This chart includes 23 subsurface and surface atigraphic sections showing thickness, lithology, d lateral change of the various rock units; an index ap showing locations of the stratigraphic sections, e outcrop area of Mississippian rocks, and location gas fields; a correlation chart of the stratigraphic mes and a brief text on the stratigraphy.--U. S. ol. Survey.

1041. Hoare, Joseph M., and Warren L. Coon-d. **GEOLOGY OF THE RUSSIAN MISSION QUAD-NGLE, ALASKA:** U.S. Geol. Survey, Misc. Inv. ap I-292, scale 1:250,000, lat. 61°-62°N., long. 9°-162°W., 1959, pub. 1960.

This map shows the geology of about 7,000 sq. mi. SW. Alaska, along the Yukon and Kuskokwim vers, W. of the Kuskokwim Mountains. The map ows the structure and distribution of rock units nging in age from Carboniferous to Quaternary. brief description of the rock units accompanies map.--U. S. Geol. Survey.

1042. Dibblee, Thomas W., Jr. **GEOLOGIC AP OF THE HAWES QUADRANGLE, SAN BER-ARDINO COUNTY, CALIFORNIA:** U.S. Geol. Sur-y, Mineral Inv. Map MF-226, scale 1:62,500, lat. $^{\circ}45'$-35°N., long. $117^{\circ}15'$-$117^{\circ}30'$W., 1960.

1043. Dibblee, Thomas W., Jr. **PRELIMINARY EOLOGIC MAP OF THE SHADOW MOUNTAINS UADRANGLE, LOS ANGELES AND SAN BERNAR-NO COUNTIES, CALIFORNIA:** U.S. Geol. Survey, ineral Inv. Map MF-227, scale 1:62,500, lat. $^{\circ}30'$-$34^{\circ}45'$N., long. $117^{\circ}30'$-$117^{\circ}45'$W., 1960.

1044. Adkison, W.L. **SUBSURFACE CROSS CTION OF PALEOZOIC ROCKS FROM BARBER UNTY, KANSAS, TO CADDO COUNTY, OKLA-MA:** U.S. Geol. Survey, Oil & Gas Inv. Map -61, 2 sheets, vertical scale 1 in. to 200 ft., rizontal scale 1 in. to 6 mi., 1960.

The chart shows lithology, thickness, correlation, d facies changes of Cambrian, Ordovician, Siluri-, Devonian, Mississippian, Pennsylvanian, and rmian rocks from Barber County, Kansas, across e Anadarko basin to the N. flank of the Wichita ountains in Caddo County, Oklahoma. It includes table of oil and gas fields and districts within 6 mi. the cross section, a map showing location of the oss section in relation to the Anadarko basin and jacent major structural features, and descriptive xt.--U. S. Geol. Survey.

1045. Balsley, James R., Randolph W. Brom-y, E.W. Remington, and others. **AEROMAGNETIC AP OF THE KERBY AND PART OF THE GRANTS ASS QUADRANGLES, JOSEPHINE AND CURRY UNTIES, OREGON:** U.S. Geol. Survey, Geophys. v. Map GP-197, scale 1:96,000, lat. 42°-$42^{\circ}30'$N., ng. $123^{\circ}25'$-124°W., 1960.

2-1046. Pennsylvania, Dept. of Forests and Waters. **WELLS DEEPER THAN UPPER DEVONIAN IN PENNSYLVANIA AND SOME WELLS IN ADJOINING PORTIONS OF NEW YORK, OHIO, WEST VIRGINIA AND MARYLAND:** 8 sheets, scale approx. 1 in. to 2 1/2 mi., separate text, [Harrisburg, 1960].

Wells deeper than Upper Devonian, structural axes, state leases, state land boundaries, and quadrangle outlines are shown on the map. The base for the map is the U. S. Geological Survey topographic 15-minute quadrangle series. Topographic detail and limits of the scale prevent all wells from being shown. All wells are shown where locally possible, and where impossible the significant wells have been plotted.

Accompanying the map is "Summary of Commonwealth of Pennsylvania Oil and Gas Leases Active and Cancelled on State Forest Land and Lake Erie Acreage Administered by the Department of Forests and Waters and on State Game Land Administered by the Game Commission," compiled by Hugh B. Montgomery. Lease date, county location, acreage, bidders, high bid, and lease status are given for all state oil and gas leases. This information is current as of Jan. 1, 1960.

2-1047. Houston Geological Society. **GEOLOGIC STRIP MAPS. U.S. HIGHWAY 90, TEXAS-LOUISIANA STATE LINE TO VAN HORN. U.S. HIGHWAY 80, VAN HORN TO TEXAS-NEW MEXICO STATE LINE:** 49 p., maps, chart, sec., Houston, Texas, Houston Geological Society, 1959, refs.

This illustrated log covers U. S. Highway 90 from the Louisiana-Texas state line through Houston and San Antonio to the intersection with U. S. Highway 80 at Van Horn. The log then follows U. S. Highway 80 from Van Horn through El Paso to the Texas-New Mexico state line. The log is designed to keep the geologist oriented in the geologic column by showing the location of formation contacts, location of good exposures, and other geologic features. Where possible, subsurface contours are also shown. Information of general interest, in addition to the geology, has been included. For certain oil fields shown on the log, production, depth, and age of the producing formation are given. Small-scale maps of county highways, as well as elevations, population, rainfall, temperatures, growing season, radio and TV stations are included for each county traversed. The location for motels and restaurants are designated by symbols along the highway.--From Introd.

PART 2. AREAL AND REGIONAL GEOLOGY

See also: Geohydrology 2-1238; Mineral Deposits 2-1266; Fuels 2-1292.

2-1048. Underhill, Frank H., ed. **THE CANADIAN NORTHWEST: ITS POTENTIALITIES. SYMPOSIUM PRESENTED TO THE ROYAL SOCIETY OF CANADA IN 1958:** 104 p., 2 maps (1 in pocket, scale 1 in. to 50 mi.), 2 tables, Toronto, University of Toronto Press, 1959, refs.

The papers give a broad picture of the resources and potentialities of this great region, about one-fifth of the area of Canada. The 7 papers included in this symposium are listed below in the order in which they appear; those with capitalized titles are abstracted separately below.

d'Eschambault, Abbé Antoine. Introduction, p. 3-5.

Legget, Robert F. AN ENGINEERING ASSESSMENT, p. 6-22.

Wonders, William C. Assessment by a Geographer, p. 23-34.

Lang, A. H., and R. J. W. Douglas. MINERALS AND FUELS, p. 35-60.

Rawson, D. S. Biological Potentialities, p. 61-75.

Turner, D. B. The Resources Future, p. 76-89.

Zaslow, Morris. A Prelude to Self-Government: the Northwest Territories, 1905-1939, p. 90-104.

2-1049. Legget, Robert F. AN ENGINEERING ASSESSMENT (In: Underhill, Frank H., ed. The Canadian Northwest: Its Potentialities...: p. 6-22, table, Toronto, University of Toronto Press, 1959) 5 refs.

Significant developments in the Canadian NW. in the last 10 years include the completion of the DEW line, trans-polar flight schedules, roads in the Yukon and Mackenzie Valley, the opening of U, Pb, and Zn mines, and the expanded exploration for oil and gas. High water-power potential is available in the Yukon, upper Fraser, Mackenzie, and Slave rivers. Transportation facilities, once practically limited to natural waterways, have been expanded by the development of airfields, roads, and pipelines. Transportation still presents costly and difficult problems in the NW. The problem of fire and cost of materials on the site are prime factors in planning buildings. Extreme cold, high winds, and length of seasons characterize the climate. Permafrost exists as far S. as Uranium City in the Mackenzie Valley; it extends to 150-ft. depth at Norman Wells and to about 1,300 ft. at Point Barrow, Alaska. It does not present unusually difficult engineering problems except where the soils are fine grained and waterlogged, a combination unfortunately common in the lower part of the Mackenzie Valley.--M. Russell.

2-1050. Lang, A. H., and R. J. W. Douglas. MINERALS AND FUELS (In: Underhill, Frank H., ed. The Canadian Northwest: Its Potentialities...: p. 35-60, map, Toronto, University of Toronto Press, 1959) 8 refs.

The Canadian NW. has important mineral and fuel resources, and some of the additional occurrences already found will probably respond to tests or to improved circumstances. However, these more or less definite potentialities are far outweighed by the possibilities for additional discoveries in this vast area, still in the early stages of prospecting and containing large geologically favorable tracts. Excepting occasional spectacular finds, increase in the production of minerals will depend mainly on increase in national or international demands. The greatest uncertainty is not in the ultimate potential but rather in the rate of growth of the demands. Under present conditions the most favorable discoveries would be those of unusually high metal content or specifications and discoveries of metals or minerals not being produced now in sufficient amounts for present markets. The extent to which fuel potentialities are developed will depend largely on the requirements of the NW. and will be augmented as demands in other parts of Canada or elsewhere warrant.--From auth. summ.

2-1051. Alberta Society of Petroleum Geologists. NINTH ANNUAL FIELD CONFERENCE. MOOSE MOUNTAIN-DRUMHELLER, SEPTEMBER 1959: 196 p., illus., maps (3 in pocket), secs., logs, tabl [Calgary?], 1959, refs.

The Ninth Annual Field Conference, held in Sept. 1959, was based at Calgary, Alberta. Surface pape highlight the geology of the 2 widely separated outcrop areas at Moose Mountain and Drumheller; sub- surface regional papers and producing field papers treat the geology of the intervening area.

The trip to Moose Mountain, a Paleozoic inlier situated in the foothills close to the Front Ranges of the Rocky Mountains, only 50 mi. SW. of Calgary, provides an opportunity to examine Mississippian rocks which provide the reservoirs for the major oi and gas fields under the foothills and plains of south western Alberta.

The trip to Drumheller, center of a coal mining district about 90 mi. NE. of Calgary, permits examination of Upper Cretaceous coal-bearing rocks exposed in deeply incised valleys - the Badlands of the Red Deer River valley. Here abandoned coal mines located close to wells of the Drumheller and West Drumheller oil fields, illustrate graphically the trends of energy sources from coal to hydrocarbons and of exploration from surface to subsurface.--Fro pref. by G. H. Austin.

Eighteen papers are abstracted separately below in the order in which they appear in the guidebook. The 3 papers for which only abstracts are given, and the road logs, are listed below.

Belyea, H. R. Elk Point Group, Southern and Central Alberta, p. 87-90.

Storey, Taras P. Basal Upper Devonian Strata between Drumheller and Rocky Mountains, Alberta, p. 91.

Andrichuk, John M. Facies Analysis of Upper Devonian Wabamun Group in West-Central Alberta, p. 103.

Woodward, H. W. and Committee, Field Trip Road Logs, p. 165-167, 10 refs.

Field Trip No. 1 - Drumheller Area, p. 167-179 (4 road logs).

Field Trip No. 2 - (Moose Mountain Area), Foothills and Front Ranges, p. 179-196 (4 road logs).

2-1052. Beach, Floyd K. ALBERTA ENERGY SOURCES, COAL TO HYDROCARBONS; EXPLORATION, SURFACE AND SUBSURFACE (In: Alberta Society of Petroleum Geologists. Ninth Annual Fiel Conference... 1959: p. 3-7, [Calgary?], 1959) 7 refs

The same energy sources we enjoy today have bee in existence over the ages. It is only in our ability to discover and utilize them that we gain advantages that our ancestors did not have.

Utilization is as important a factor as possession of energy sources, but possession of the sources is not at all evenly distributed, and Alberta has within her boundaries just over half of Canadian coal reserves, and five-sixths of Canadian oil and gas reserves. Installed hydroelectric generating capacity is relatively small, a mere 1.6% of the Canadian total, but it is very useful and will expand to some extent with demand.

Atomic fuel looms as a future source of energy, but present forecasts suggest that U is not likely to replace coal, oil, and natural gas in parts of the world where they are easily accessible. Alberta ha no known U that can be mined economically, althoug deposits at Great Bear Lake and Lake Athabasca are close.

Alberta has been handicapped geographically in lizing energy sources for manufacturing. Every m we bring to the province costs more because of ight rates and everything we have to sell is less nunerative because of transmission costs. As bulation grows in the province the handicap lessens. the meantime Albertans must be efficient in ex- biting such natural advantages as they possess.-- th.

1053. Langston, Wann, Jr. **ALBERTA AND SSIL VERTEBRATES (In: Alberta Society of Petro- m Geologists. Ninth Annual Field Conference... 59: p. 8-19, 3 illus., map, chart, [Calgary?], 59) ref.**

The history of the backboned animals is very in- mpletely documented by the fossil record in Alber- Yet in point of time encompassed, the Alberta cord provides more glimpses of this history than es that of any other province.

Paleozoic vertebrates in Alberta consist of a hand- l of fish remains from Devonian and Mississippian cks. Because of the absence of genetically appro- iate sediments, chances of finding terrestrial leozoic vertebrates in Alberta are not good but ad- ional marine fossils can be expected.

Except for the late Cretaceous dinosaur faunas, thout parallel elsewhere in the world, much the me must be said for the Mesozoic vertebrate rec- ds. Possibility of amplifying the late Jurassic d early Cretaceous records exists in the southwest- n part of the province.

Paleocene vertebrates are known from several calities; specimens consist of a few tiny mammal eth, scraps of fish, reptile, and an amphibian. ere is but one bone attributable to a post-Paleocene rtiary vertebrate from Alberta. Probability of panding the later Tertiary record is virtually nil, ing to absence of sedimentary deposits of appro- iate age and consistency.

Quaternary fossils occur, but as yet are poorly own. Prospects for improving this situation are oderately good, however. --Auth.

1054. Broscoe, A.J., and Robert H. Barton. **EOMORPHOLOGY OF THE DRUMHELLER-MOR- N AREA, SOUTH-CENTRAL ALBERTA (In: Alber- Society of Petroleum Geologists. Ninth Annual eld Conference... 1959: p. 20-22, map in pocket, algary?], 1959) 9 refs.**

The Drumheller-Morrin area is underlain by Up- r Cretaceous and Tertiary marine, brackish-water, d continental sediments, dipping very gently to e W. into the Alberta syncline. The bedrock is scured by 2 till sheets and a disintegration mo- ine, which includes central-depression prairie ounds, moraine plateaus, and disintegration ridges. tensive Pleistocene lake deposits accumulated in lake stages at successively lower levels. The rap- down-cutting by the Red Deer River, probably in stglacial time, is thought to be the result of an creased discharge due to diversion of the present adwaters of the Red Deer River into the present stem N. of the town of Red Deer. Rapid erosion the nonresistant Edmonton formation exposed in e valley walls resulted in the formation of spectac- ar badlands which are undergoing further erosion the present time.--Auth.

1055. Usher, John L. **THE GEOLOGY OF THE ESTERN FRONT RANGES SOUTH OF BOW RIVER, LBERTA (In: Alberta Society of Petroleum Geologists. Ninth Annual Field Conference... 1959: p. 23-36, 7 illus., map in pocket, table, [Calgary?], 1959) 18 refs.**

The Front Ranges subprovince of the Rocky Mountains along Bow River valley is bounded on the E. and W. respectively by the McConnell and Castle Mountain thrust faults. It comprises, from E. to W., the Fairholme, the Cascade-Rundle, the Norquay-Sulphur-Goat, the Sawback-Bourgeau, and the Pilot-Fatigue Ranges. Excepting the latter, each range is underlain by a major thrust fault; the Pilot-Fatigue Range is closely tied to the Sawback-Bourgeau Range, the 2 being separated by the Brewster Creek syncline, and the Fatigue thrust fault which has variable but not excessive stratigraphic throw. Topographically the 2 ranges are distinct.

The stratigraphic section includes the Middle and Upper Cambrian, Lower Ordovician, Upper Devonian, Mississippian, Permian, Triassic, and Jurassic. Pre-Devonian rocks are exposed on all ranges except the Norquay-Sulphur-Goat Range; there the Devonian Fairholme group forms the hanging wall of the Sulphur fault, and the foot wall rocks are overturned quartzites of the Rocky Mountain group and not the hitherto reported Ordovician Mt. Wilson quartzite. Middle and Upper Cambrian formations on the Rundle and Sawback ranges have previously been described; the author recognizes 5 mappable Upper Cambrian rock units in the Sawback-Bourgeau Range and refers to them by letters A, B, C, D, and E, abeyant to future unravelling of Upper Cambrian stratigraphy and nomenclature in Main Ranges type sections.

Upper Devonian formations increase in thickness westward. The Fairholme group is in carbonate facies in the Cascade-Rundle Range, the Norquay-Sulphur Range, the Sawback Range and in the N. end of the Bourgeau Range. S. of Mt. Allenby the Fairholme group becomes shaly, and the Alexo formation loses a thick middle carbonate member to become a uniform succession of quartzitic siltstones and silty dolomites. A similar succession occurs in the Pilot-Fatigue Range.

The Alexo formation thickens to 400 ft. in the W. and is composed of dolomite, fine quartzites, and silty dolomites. The Palliser formation thickens to 1,850 ft. in the westernmost Front Range.

Mississippian rocks thicken westward; the Exshaw formation may reach 70 ft. The lower Banff formation contains much black shale and chert. Permian and Triassic rocks are present on back slopes of all ranges except the Pilot-Fatigue Range. Jurassic rocks occur in the upper Spray River valley on the lowest back slope of Goat Range.--Auth.

2-1056. Illing, L.V. **CYCLIC CARBONATE SEDIMENTATION IN THE MISSISSIPPIAN AT MOOSE DOME, SOUTHWEST ALBERTA (In: Alberta Society of Petroleum Geologists. Ninth Annual Field Conference... 1959: p. 37-52, 3 pls., map, 3 charts, [Calgary?], 1959) 34 refs.**

This paper is part of a longer article entitled "Deposition and Diagenesis of some Upper Palaeozoic Carbonate Sediments in Western Canada" (Geoscience Abstracts 1-2081).

The Mississippian seas covering western Canada shallowed northeastward towards a shoreline on the Canadian Shield and deepened southwestward to the present Cordilleran area. Various types of limestone, controlled in the main by depth of water and the degree of contamination by terrigenous sediment, were formed in belts across this shelving epicontinental sea. Changes in sea level caused these belts to move back and forth. The genesis and diagenesis of the resulting cyclic sequence of limestones and dolomites are discussed in terms of the typical succession exposed in the Moose Dome inlier of the foothills of southern Alberta.

The Banff formation at the base consists predominantly of argillaceous, cherty, pasty limestones formed by the anaerobic rotting of skeletal detritus below wave base. Bioclastic lime-sandstones (Pekisko formation) appeared as the seas shallowed, first with interstitial pasty matrix and then clean-washed as the energy of the depositional environment increased. Thin oölitic beds are the first sign of increased salinities. Continued shallowing segmented the seas into lagoons where lime-muds were precipitated to form the lithographic limestones of the Shundra formation. Associated dolomite muds accumulated in local, more saline lagoons.

A return to open shelf conditions started the second cycle with the deposition of clean-washed lime-sands (Turner Valley formation) composed predominantly of crinoid ossicles and bryozoan fragments. Reservoir rocks of porous and permeable dolomite are common in these sediments, particularly those formed from the more heterogeneous bioclastic detritus. The dolomitization is believed to be epigenetic, formed during a late phase of diagenesis.

Cryptocrystalline dolomites, brecciated by the solution of associated anhydrite, occur in the overlying Mount Head formation, which represents the evaporitic phase of the second cycle.--Auth.

2-1057. Dahlstrom, C.D.A., and G.G.L. Henderson. **STRUCTURAL GEOLOGY OF THE MOOSE MOUNTAIN AREA, ALBERTA** (In: Alberta Society of Petroleum Geologists. Ninth Annual Field Conference...1959: p. 53-62, illus., 2 maps (1 col. geol. map in pocket, scale 1 in. to 4 mi.), 3 diags., [Calgary?], 1959) 20 refs.

The surface geology of the Moose Mountain area provides excellent illustrations of type structures and fundamental processes in foothills geology. The area consists of a series of fault plates separated by major sole thrusts.

In one instance the upper and lower boundary sole thrusts converge to form a wedge-shaped fault plate, a typical foothills structure. Study of the junction relationships indicates the lower or more easterly sole thrust was formed, and probably folded, before the upper or more westerly sole thrust developed.

All thrusts eventually terminate laterally or vertically. Lateral die-out is illustrated in several cases where it is apparently accomplished by transfer of motion to adjacent faults. Evidence of vertical die-out is provided by the Turner Valley sole fault where motion was dissipated upward in a crumpled zone along the eastern edge of the Foothills.--Auth.

2-1058. Hargreaves, Gordon R. **NISKU LITHOFACIES OF ROCKY MOUNTAINS, ALBERTA** (In: Alberta Society of Petroleum Geologists. Ninth Annual Field Conference...1959: p. 63-72, 9 illus., map, table, [Calgary?], 1959) 15 refs.

The Nisku formation of the Winterburn group of Upper Devonian age is mapped throughout a portion of the Alberta Rocky Mountains. The area studied extends from the Moose Mountain area in the S. to the Smoky River area in the N. Based on lithological similarities to well established lithofacies types of the plains area, the formation is mapped into approximate areas of 5 predominant informal rock types as follows: dolomite, porous in part; dolomite, silty an argillaceous; limestone and dolomite, interbedded; limestone; shale and limestone, interbedded. All rock types are considered to be the same approximate age, but an exception is noted in that the upper part of the Nisku shale and limestone facies, which has previously been included with the Alexo, may be of post-Nisku age in the SE. part of Jasper National Park.

The Nisku lithofacies map is based on 53 measure outcrop sections and 18 well sections. A summary selected outcrop sections is tabulated.--Auth.

2-1059. van Hees, H. **MIDDLE CAMBRIAN OF THE SOUTHERN ALBERTA PLAINS** (In: Alberta Society of Petroleum Geologists. Ninth Annual Field Conference...1959: p. 73-85, 3 maps, 3 profiles, [Calgary?], 1959) 16 refs.

The Cambrian of the plains has been divided into Upper and Middle Cambrian. Correlations leading to this subdivision, which incorporate all conclusive paleontological evidence available to the author, are presented in 3 profiles, 2 of which extend into western Saskatchewan where the Middle Cambrian is wid spread. Middle Cambrian nomenclature typical of the Banff-Yoho Parks area is extended to the plains. Maps and profiles emphasize 2 main lithologic types carbonates, characteristic of the Rocky Mountains outcrops, in the W.; and coarse, mainly rounded clastics, a diachronous eastern facies component that has its source on the Precambrian Shield.

A structure map and an isopach map with superimposed elementary facies outlines in plains and mountains, further illustrate some aspects of the Middle Cambrian. Facies and thicknesses are closely related. Thicknesses increase from E. to W. Four facies provinces governed by depth of depositio and distance from the clastic source area of the Precambrian Shield are arranged in belts with roughly NW.-SE. trending boundaries. From E. to W. these are: a) coarse basal clastic belt; b) glauconitic silt-shale belt; c) submerging shelf carbonate belt, culminating in a section of approximately 4,000 ft. containing reefoid rocks in the Rocky Mountains; d) western deeper water shale belt, W. of a line from Field, British Columbia, to Blairmore, Alberta, and farther SW. through Cranbrook, British Columbia, where it attains a thickness of over 5,000 ft.

In the plains a number of positive and negative depositional trends are observed. The negative trends are associated with carbonate deposition; the positive trends are devoid of carbonates.

Oil shows are summarized. Attention is given to the possibility that petroliferous reef-type carbonates, as found in the Eldon formation of the mountains, may extend into the foothills and plains.--Auth

2-1060. Kirker, William P. **DEVONIAN REEF AND OFF-REEF RELATIONSHIPS IN THE DRUMHELLER AREA** (In: Alberta Society of Petroleum Geologists. Ninth Annual Field Conference...1959: p. 92-102, 3 maps, chart, 2 secs., [Calgary?], 1959 13 refs.

Rapid facies changes associated with reef development occur in the Devonian Winterburn and Woodbend sediments of the Drumheller area. To indicate the facies relationships, the "limy" and "dolomitic" sediments are divided into several informal rock types. The "dolomitic" sediments are classified according to their interpreted original or undolomitize rock types.

he Cooking Lake formation, composed of pre-
inantly pelletoidal and fragmental limestones,
s the base of reef development in portions of
outhern Alberta reef complex. A line of organic
ls is indicated in the Cooking Lake 6 to 8 mi. in
of the reef complex.

he Duvernay formation is closely associated with
development. It is composed predominantly of
detritus close to the reef complex and contains
ient reef developments in a lime mud facies
nd the detrital zone.

he Ireton formation is a lime mud facies with
es of fragmental carbonate. The upper portion
e Ireton is dolomitic and contains a dark organic
mite band which becomes the main constituent
e Ireton interval over the reef complex.

he southern Alberta reef complex, an informal
used to designate the Woodbend carbonates of
outhern portion of the study area, is composed
agmental carbonate and reefoid beds. Organic
rial predominates in a band approximately 3
wide along the reef front.

he Nisku interval contains shoals of light organic
mite with associated fossil fragmental dolomites
pelletoidal dolomites separated by intershoal
s of dark dolomitic muds and bedded dark organ-
lomites.

he depositional environment of the sediments
ates a period of almost continuous reef growth
ified by cycles of emergence and submergence.
emergence or lowering of the sea level is as-
ated with erosion of the reef while the submer-
e was probably a period of rapid growth.--Auth.

061. Penner, D.G. MISSISSIPPIAN OF SOUTH-
TRAL ALBERTA (In: Alberta Society of Petro-
n Geologists. Ninth Annual Field Conference...
9: p. 104-112, 3 maps, sec., 2 tables, [Calgary?],
9) 13 refs.

ississippian rocks are truncated in a NE. direc-
across the map-area. The erosional limits of
various formations are shown.

he Bakken is thickest in the E. part and thins
hward and westward, where only the lower black
e unit is recognizable.

he Banff thins eastward and changes from a ba-
l facies in the foothills to a shelf facies in the
ns. The Banff formation of the type section is not
Banff formation of the plains. In order to be con-
ent with established plains usage, it is proposed
the Banff formation and the Rundle group at the
section be redefined.

he Elkton member of the Turner Valley is the
t important oil and gas reservoir in the area.
umulation occurs at the erosional updip edge of
Elkton, in stratigraphic traps controlled by facies
nges, channelling, and by the overlying imper-
ble Mesozoic shales.

otal recoverable reserves from the Turner Val-
is 306,364,000 barrels of oil - 88% of the total
rves of all producing zones in the area.--Auth.

062. Thomas, G.E., and R. Perry Glaister.
IES AND POROSITY RELATIONSHIPS IN THE
SISSIPPIAN ELKTON CARBONATE CYCLE OF
THWESTERN ALBERTA (In: Alberta Society of
roleum Geologists. Ninth Annual Field Confer-
e...1959: p. 113-121, 7 illus., 3 logs, [Calgary?],
9) 3 refs.

Major hydrocarbon (oil and gas) reserves have
n found in the Mississippian Elkton carbonate cycle, both in the foothills belt and along the subcrop, in southwestern Alberta. Effective reservoir material of this cycle was found to consist mainly of the dolomitized equivalent of an originally coarse skeletal limestone with a variable amount of generally porous, finely comminuted (granular) skeletal matrix. Primary porosity was very important in the control of dolomitization, which probably began with the replacement of this matrix by euhedral rhombohedrons and finally affected the coarse skeletal material (now generally indicated by leached fossil cast outlines). These porous dolomites grade laterally in a predictable way into tight, relatively undolomitized, well-sorted, coarse skeletal limestones with original high interfragmental porosity now completely infilled with clear crystalline calcite. This lithification by cementation took place early in the history of carbonate sedimentation of this area and before secondary dolomitization processes took effect.--Auth.

2-1063. Workman, Lewis E. THE BLAIRMORE GROUP IN THE SUBSURFACE OF ALBERTA (In: Alberta Society of Petroleum Geologists. Ninth Annual Field Conference...1959: p. 122-129, map, chart, 2 logs, [Calgary?], 1959) 14 refs.

Cross sections extending through the subsurface from Fort St. John, British Columbia, eastward to the Fifth Meridian in Alberta, thence southward to the International Boundary, show the stratigraphic relationships of the various units of the Blairmore group [Cretaceous]. Emphasis is placed on the widespread occurrence of the Glauconitic sand; it is proposed that it be known hereafter as the Bluesky formation. The subsurface sections are 'tied in' to an outcrop section along Sheep River, SW. of Calgary.--Auth.

2-1064. Roessingh, H.K. VIKING DEPOSITION IN THE SOUTHERN ALBERTA PLAINS (In: Alberta Society of Petroleum Geologists. Ninth Annual Field Conference...1959: p. 130-137, 3 maps, 3 diags., [Calgary?], 1959) 16 refs.

An examination of Viking [Cretaceous] cores from wells located between Townships 14 and 34 from the Saskatchewan border to the foothills belt was used as the basis for this paper. A number of microstructural features are considered to be evidence of penecontemporaneous hydroplastic deformation. These features contradict the theory that the Viking is a shore or offshore sediment, deposited during repeated minor transgressions and regressions. Deposition by turbidity currents is offered as an alternative interpretation.--Auth.

2-1065. Brennan, P.F., and A.S. Warden. WIMBORNE OIL AND GAS FIELD, ALBERTA (In: Alberta Society of Petroleum Geologists. Ninth Annual Field Conference...1959: p. 138-144, illus., 3 maps, chart, log, [Calgary?], 1959) 4 refs.

Discovered in 1954, Wimborne oil and gas field lies in southwestern Alberta, 50 mi. NE. of the city of Calgary. The main oil and gas accumulation occurs in a dolomitized reef of Devonian Leduc age, with a secondary accumulation occurring at a higher elevation in the biostromal development in the Nisku formation of the Devonian Winterburn group. Nineteen wells have been drilled to the Leduc reef in the field area, of which 13 are on steady production. No production is presently being taken from the Nisku.--Auth.

2-1066. Roop, M.R. **DRUMHELLER OIL FIELDS, ALBERTA** (In: Alberta Society of Petroleum Geologists. Ninth Annual Field Conference... 1959: p. 145-151, illus., map, 2 secs., log, [Calgary?], 1959) 4 refs.

The Nisku, Leduc, and Basal Quartz are the producing zones in the West Drumheller and Drumheller oil fields, which were discovered between 1950 and 1952. The Nisku formation of the Upper Devonian is the primary reservoir. Production is also obtained from the Leduc reef at West Drumheller, and from the Lower Cretaceous Basal Quartz sandstone in Drumheller. The Nisku consists of 2 units: an upper unit of dense, evaporitic dolomite and anhydrite, and a lower unit of porous crystalline dolomite, which is the reservoir rock. The trap at West Drumheller is due to reef buildup; at Drumheller it is stratigraphic. Reservoir and development data are presented in the text.--Auth.

2-1067. Mason, A.D.M., and C. Riddell. **EAST CALGARY GAS FIELD** (In: Alberta Society of Petroleum Geologists. Ninth Annual Field Conference... 1959: p. 152-157, 3 maps, sec., [Calgary?], 1959) 2 refs.

The East Calgary gas field in southern Alberta is located at the junction of 2 trends of stratigraphic traps. The lower reservoir, the Crossfield dolomite member of the Upper Devonian Three Forks formation, contains substantial reserves of highly sulfurous gas trapped by an eastward updip porosity pinchout. The upper reservoir, the Elkton member of the Mississippian Turner Valley formation, contains sizeable wet-gas reserves within a lobe of porous dolomite formed by progressive eastward erosional truncation of the Mississippian surface. Minor gas reserves may be present within basal Cretaceous sands lying immediately above the Mississippian unconformity. Step-outs and infill drilling is continuing slowly within the field area of approximately 2 townships.--Auth.

2-1068. Erickson, R.H., and J.S. Crewson. **WAYNE OIL FIELD, ALBERTA** (In: Alberta Society of Petroleum Geologists. Ninth Annual Field Conference... 1959: p. 158-163, illus., 2 maps, sec., log, table, [Calgary?], 1959) 7 refs.

The Wayne oil field is located in S.-central Alberta and, since its discovery in 1954, has produced over 320,000 barrels of 29.5° A. P. I. oil from the Lower Cretaceous Sunburst sandstone. The sandstone is characterized by a clay infilling which reduces production but causes the trap. Of 7 wells drilled, 6 are on pump and 1 is suspended.--Auth.

2-1069. McMurchy, R.C. **GEOLOGY OF THE SAGANASH LAKE-WAKUSIMI RIVER AREA**: Ontario Dept. Mines, Ann. Rept., v. 69, pt. 3, 1960, 19 p., 5 illus., 2 maps (1 fold. col. in pocket, scale 1:63,360), 1960, ref.

The map-area includes Staples, Fenton, Seaton, Casselman, Slack, Griffin, and Macvicar townships, district of Cochrane ($48^{\circ}51'$-$49^{\circ}11'$N. $82^{\circ}06'$-$82^{\circ}39'$ W.). Except for unconsolidated Pleistocene and Recent deposits, rocks of the area are all Precambrian, chiefly igneous. The extrusive rocks are dominantly hornblende schist and quartz-hornblende schist. With them are amphibolite, some greenstone, and minor amounts of sedimentary types and volcanics, sediments, or tuffs. The volcanic and sedimentary rocks have been folded and metamorphosed by the intrusi and are now mainly schists. The Fe formation is member of this group. Pleistocene deposits are wi spread.

Little prospecting has been done, except on the formation in 1946 and 1947, and that carried out du ing mapping in 1958. Occurrences of Fe, sulfides, Au, and sand and gravel are very briefly described Exploration did not reveal mineral deposits of economic significance, but the volcanic and sedimenta rocks warrant prospecting. The sulfides intersect in the diamond drilling in Fenton Township suggest that base metal deposits may be present in important amounts.--A. C. Sangree.

2-1070. Bérard, Jean. **PRELIMINARY REPORT ON TOCO-TÉMISCAMIE AREA, MISTASSINI TERRITORY**: Quebec, Dept. Mines, Prelim. Rept. no 411, 10 p., fold. geol. map (Prelim. Map no. 1313 scale 1:63,360, 1960, 4 refs.

The area ($51^{\circ}30'$-$51^{\circ}45'$N. 72°-$72^{\circ}30'$W.), mapp in summer 1959, covers about 376 sq. mi., about 2 mi. N. of Lake St. Jean. All rocks are early Prec brian except for several diabase dikes of unknown and Pleistocene and Recent deposits. The early Pr cambrian rocks are divided into 2 groups, the west ern complex and the eastern complex, separated b a presumed fault that follows the valley of the Tém camie River. Rocks close to this zone are general crushed and sheared. Gneissic structure of rocks the western complex is extremely variable; that of the eastern complex trends generally ENE. The w ern complex consists mainly of biotite gneiss and hornblende-biotite gneiss, both injected by granite and biotite-rich pegmatites. Large intrusive mass of granite and pegmatite occur. The eastern comp is made up of 4 distinct units. The oldest is an assemblage of biotite paragneiss, banded composite gneiss and garnet-bearing amphibolites. This unit is cut by 3 types of intrusive rocks, varying in con position from anorthosite to pyroxene-hornblende granite and biotite granite gneiss.

Pyrite, pyrrhotite, and traces of chalcopyrite h been found in practically all the shear zones. Mag netite and limonite occur within the anorthosite an diorite S. of Témiscamie River.--A. C. Sangree.

2-1071. Berrangé, J.P. **PRELIMINARY REPO ON LA TRAPPE-HUDON AREA, ROBERVAL ELE TORAL DISTRICT**: Quebec, Dept. Mines, Prelim Rept. no. 404, 12 p., fold. geol. map (Prelim. M no. 1291), scale 1:63,360, 1959.

The La Trappe-Hudon area (49°-$49^{\circ}15'$N. 72°- 15'W.), mapped in summer 1958, comprises about 196 sq. mi. The area is underlain by Precambrian rocks. The oldest rocks, highly folded Grenville metasedimentaries and associated orthogneisses, occur in the southern part of the area. A portion the Lake St-Jean anorthosite massif underlies the northern three-quarters of the area. These anort sitic rocks consist of a complex assemblage of an thosite, dioritic anorthosite, and anorthositic dior The last type grades into a slightly younger diorite which predominates near the edge of the massif. Brown, equigranular gabbro stocks and dikes cut t complex. A second intrusive group, presumably the same magmatic stem as the anorthositic rocks include rocks varying from granite, syenite, and monzonite to diorite and augen gneiss. Numerous acidic intrusive rocks including pegmatite, aplite, fine-grained granite dikes, and quartz veins occur and there throughout the area. Thin, dark, dikes are the youngest rocks.--Auth., p. 2.

he Grenville rocks are folded into a complex es of open and overturned folds whose axial lines ge between 10° and 35°N. to NE. Several sets ints have been recorded. No evidence of major s was found.

on, brucite, sulfides, and mica prospects are ly described. Some of the black anorthosite has ntialities as a building and monument stone, and bundant supply of sand and gravel exists.

72. Carbonneau, Côme. RICHARD-GRAVIER A, GASPÉ PENINSULA: Quebec, Dept. Mines, . Rept. 90, 63 p., 14 illus. on 8 pls., 3 maps, l. geol. map in pocket, scale 1:63,360), secs. ocket), 3 diags., 4 tables, 1959, 39 refs.

he map-area (48°30'-48°45'N. 66°-66°30'W.) rs about 400 sq. mi. in the center of Gaspé Pen- a. It was mapped in summers 1950 and 1951. eologically, Gaspé peninsula is divisible into 3 running E.-W. along its long axis: 1) a northern composed of slates of predominantly Ordovician 2) a central one made up of rocks of Devonian and 3) a southern belt composed of rocks of pre- nantly Ordovician and Silurian ages, but includ- lso some Devonian, Carboniferous, and possibly ambrian rocks. The greenstone series (Cam- n(?) or older) of the Shickshock Mountains, the dotite (Silurian) of Mount Albert, and the granite onian) of the Tabletop mountains are located be- n the northern and central belts, in the western of the peninsula.

he Richard-Gravier map-area belongs to the al belt of the peninsula. The rocks range in age Upper Silurian (lower Ludlow) to possibly Mid-Devonian, with a short stratigraphic gap repre- ing a portion of Late Silurian time. The present rt, however, is concerned mainly with the Devo- succession which, in this area, reaches an un- l thickness.

he principal structure of the area is the Berry tain syncline. This is a somewhat basinlike subcircular in surface plan, the axis of which slightly S. of W. in the central part of the area. fold affects the whole sequence of rocks, except e southeastern part of the area where the Silurian were brought up by a series of thrust faults a general anticlinal structure (Josué Brock anti-). The strata on the northern flank of the Berry tain syncline have lower dips than the strata on outhern flank, which are commonly overturned e N. near the eastern boundary of the area. The plunges to the W., except in the southwestern of the area where the axis appears to be approx- ely horizontal.

he Berry Mountain syncline is part of the syncli- um which extends along the axis of the peninsula, corresponds in position to the central belt, des- ed above. It is approximately in line with the River syncline of eastern Gaspé.--Auth, p. 12-

he map-area is located a short distance S. of ong-known base metal deposits of Lemieux Town- , and could hold promise of economic mineral rrence. Some chalcopyrite and pyrrhotite were d. Gravel deposits are fairly common. Oil seep- or other indications of petroleum have not been d, but the general region is not devoid of possibil- .

73. Deland, André N., and Paul E. Grenier. EUR-DRUILLETTES AREA, ABITIBI-EAST ELECTORAL DISTRICT: Quebec, Dept. Mines, Geol. Rept. 87, 71 p., 12 illus. on 6 pls., 5 maps (3 col. geol. maps in pocket, scale 1:63,360), tables, 1959, 60 refs.

The Hazeur-Druillettes area includes about 646 sq. mi., 240 mi. NW. of Quebec City and 45 mi. SW. of Chibougamau. It is part of a major project, initiated in 1950 by the Quebec Dept. of Mines, and involving mapping at 1 mi. to 1 in. scale a zone approximately 80 mi. long and 35 mi. wide, extending westward from the Chibougamau highway just S. of Lake Chibougamau. This region parallels to the S. the main "mineralized belt," as so far known, of the Chibougamau region. However, mineral deposits are present in this southern belt, and some of these are of economic importance. In the present area, although most of the deposits are in Keewatin-type rocks, there are deposits of considerable interest in the "Grenville gneisses" as well.

Geologically, a major objective in the present area was to study the relationship between the Keewatin-type rocks in the northwestern part of the area and the Grenville-type rocks found in the southeastern part.

All consolidated rocks are Precambrian. The northern and northwestern parts are underlain by Keewatin-type rocks which consist mainly of altered lavas (basalts to albite rhyolites) and sedimentary rocks, with some pyroclastic and intermediate to basic intrusive rocks. This complex has been sharply folded and deformed. In general, however, the strata strike in an easterly direction and are either steeply inclined or vertical. Shear zones which also strike E. are common in this northern half of the area, and many of them are mineralized.

The southern and southeastern parts of the area are underlain by gneissic granites, biotite and hornblende paragneisses, hornblende gneiss and amphibolite. Some of these metamorphic rocks, being rich in garnets and highly crystalline, are of the Grenville-type. The paragneisses and hornblende gneiss also generally strike E. However, toward the southeastern corner of the area, the trend gradually becomes NNE. In the gneissic granite, the gneissosity is much less regular, although the easterly trend still seems to prevail.

A few dikes of diabase, probably of late Precambrian age, cut the gneissic granite and the Keewatin-type rocks.

Keewatin-type rocks in the northern part of the area are at the southeastern border of the Timiskaming subprovince of the Canadian Shield, and the crystalline gneisses and granites to the S. are at the northwestern boundary of the Grenville subprovince. Thus, a segment of the postulated boundary between the 2 subprovinces crosses the area diagonally from NE. to SW. Lithologic and structural evidences as well as transitional phases indicate that the hornblende and biotite gneisses are metamorphosed equivalents of the Keewatin-type lavas and sedimentary rocks. Faulting has played only a very small part in the structural relationships.

Unconsolidated glacial material of Pleistocene age is widespread and masks much of the bedrock.

Much prospecting has been done, and development work was progressing at the end of 1954 revealing encouraging Au values. Other mineral showings include Cu, Pb, Zn, Ag, Ni, Fe, and talc.--From auth. introd. and p. 7-8, 58.

2-1074. De Montigny, Pierre A. PRELIMINARY REPORT ON UPPER DECEPTION RIVER AREA, NEW QUEBEC: Quebec, Dept. Mines, Prelim. Rept. no. 398, 8 p., fold. geol. map (Prelim. Map no. 1285), scale 1:63,360, 1959, 2 refs.

The area (61°30'-61°45'N. 73°40'-74°W.), mapped in 1958, covers about 190 sq. mi., 300 mi. NW. of Fort Chimo and 40 mi. S. of Hudson Strait. It lies within the Cape Smith-Wakeham Bay belt. This belt of Proterozoic rocks, similar in some respects to the Labrador trough or geosyncline, crosses the northern tip of the Province of Quebec in a general N.75°E. direction. Within the map-area, the rocks of the belt are divided into 2 groups: the Povungnituk, or lower, and the Chukotat, or upper, group. Both groups contain sedimentary, volcanic, and intrusive members, and, in both groups, the sedimentaries are concentrated towards the base. The Povungnituk group is composed mainly of graphitic slates and volcanic rocks with minor dolomite, chert, and quartzite, and with gabbro sills that were intruded prior to a first period of folding. This group is overlain unconformably by the Chukotat group. The Chukotat consists mainly of volcanics with some sedimentaries and with gabbro and ultrabasic sills intruded prior to a second period of folding. The sedimentary rocks of this group consist of conglomerate, graywacke, arkose, and shale. The 2 groups are separated by an unconformity which, although not observed in the present area, was noted by Bergeron farther W.--Auth.

Structure of the major part of the area consists of a series of isoclinal folds compressed along axes trending N.70°E. A major reverse fault intersects the western edge of the area about 4 mi. S. of the northern boundary. Transverse faults, apparently displacing all rocks of the area, are quite numerous. Joints are abundant in the volcanics and strike in many directions. Valleys running across the structure have been strongly influenced by the joint pattern.

Cu-Ni deposits of economic importance have been found a short distance N. of the central part of the map-area and in the NW. corner. All the main sulfide zones occur within the serpentinite. The most important sulfides are pentlandite, pyrrhotite, and chalcopyrite.

2-1075. Gélinas, Léopold. **PRELIMINARY REPORT ON THE GABRIEL LAKE AREA (EAST PART) AND THE FORT CHIMO AREA (WEST PART), NEW QUEBEC**: Quebec, Dept. Mines, Prelim. Rept. no. 407, 9 p., fold. geol. map (Prelim. Map no. 1309), scale 1:63,360, 1960, 2 refs.

The area (58°-58°15'N. 68°15'-68°45'W.), mapped during summer 1958, comprises 320 sq. mi. All consolidated rocks are Precambrian. The western part is underlain mainly by quartzofeldspathic gneisses. The central part is occupied by a large dome of quartzofeldspathic gneisses. This is surrounded by biotite-rich gneisses, garnetiferous in places, and associated with thin layers of amphibolite, impure dolomite and quartzite. Biotite gneisses with microcline porphyroblasts are also found in the central core. The eastern part is underlain mostly by pegmatite. A few pegmatite dikes are found in the western part of the area. They become more and more numerous towards the Stewart Lake dome. Here the dikes are narrow and form part of a very complex network. E. of Stewart lake, the petmatites are dominant and, in some places, constitute more than 85% of the exposures. Remnants of gneiss appear among the pegmatites. Diabase dikes cut the gneissic complex and the pegmatites near Koksoak river. Regional metamorphism in the area is high grade, as is indicated by the presence of olivine and diops in the impure dolomites, hypersthene in the amphibolite, and sillimanite in the schists.--Auth., p. 2.

Numerous traces of pyrite were noted near Chin No minerals of economic value were found.

2-1076. Gilbert, J.E. **ROHAULT AREA, ABITIE EAST AND ROBERVAL ELECTORAL DISTRICTS**: Quebec, Dept. Mines, Geol. Rept. 86, 31 p., 4 ill on 2 pls., col. geol. map (in pocket), scale 1:63,36 1959, 23 refs.

The Rohault area (49°15'-49°30'N. 74°15'-74°3 W.), mapped in summer 1951, comprises 195 sq. m about 25 mi. S. of Lake Chibougamau and 110 mi. NW. of Lake St. Jean. The region is of particular interest because it is crossed by the contact zone b tween Keewatin-type and Grenville-type rocks. Di coveries of metallic minerals were made in 1949 a 1950 along and close to the Rohault-La Dauversière line.

All consolidated rocks are Precambrian. They include volcanic, tuffaceous, gabbroic and dioritic Keewatin-type rocks in the northernmost part of th area and, to the S., a complex of paragneisses and orthogneisses generally considered as belonging to the Grenville subprovince. Numerous, generally small, late Precambrian basic dikes are present.

Fine- to medium-grained gneissic rocks underli about 85% of the area. Formerly divided into 2 different groups, the Némenjiche series and the Grenville subprovince gneisses, these rocks were found to belong to only 1 series and to be made up of 2 ty of paragneisses intruded by foliated granitic materi and pegmatite dikes.

The Keewatin-type volcanic, tuffaceous, and gab broic rocks of the northern part of the area, togeth with the northern section of the hornblende paragne zone just to the S., have a general E.-W. trend. Farther S., the structural trend of the gneisses is much more variable. Numerous drag folds were seen most of them very small. Shear zones are abundan in the northern half of the area; they are less abundant and more local in the southern part. A few small oblique faults were seen in the gneissic rocks

The northern part of the area has been the site o considerable prospecting activity since 1949-1950. An important Au-Cu-Ag deposit was discovered clo to the western shore of Norhart lake. This has bee successfully developed during 1952-1958. At the en of 1958, some 99,500 oz. Au, 73,500 oz. Ag, and 4 1/2 million lbs. Cu had been produced, and ore reserves above the 1,200-ft. level were estimated i Nov. 1958 at 218,000 tons averaging 0.205 oz. Au per ton and 0.41% Cu. Further geological and geophysical exploration work has been undertaken by about 15 companies, mostly along the belt of Keewa tin-type rock in the northern part of the map-area. Scattered mineralization of sulfides and precious metals was encountered.--A.C. Sangree.

2-1077. Leuner, W.R. **PRELIMINARY REPORT ON THE WEST HALF OF LAMOTTE TOWNSHIP, ABITIBI-EAST ELECTORAL DISTRICT**: Quebec, Dept. Mines, Prelim. Rept. no. 405, 10 p., 2 fold. geol. maps (Prelim. Map no. 1294, no. 1295), scal 1:12,000, 1959, 3 refs.

The area (48°17'-48°26'N. 78°07'-78°14'W.) cov ers about 50 sq. mi., about 27 mi. NW. of Val d'Or Three distinct types of topography exist: granite hig lands, sand plains, and lowlands underlain by lacus trine clays. Rock exposures are generally not abun

e rocks of the area are all Precambrian in age.
include folded Keewatin-type volcanic and sedi-
ary rocks which have been intruded by sill or
ke bodies of metamorphosed peridotite, dunite,
o, and diorite, and by abundant acidic or gra-
material including quartz monzonite, biotite
diorite, and their associated pegmatites and
s. Gabbro dikes of apparently late Precambrian
ansect both the batholithic and pre-batholithic
.

e general structural trend of the rock forma-
is E. to S. of E. The schistose and foliated
have a remarkably constant strike.
ree types of mineral deposits have been found
region: Ni-bearing sulfide bodies of the re-
ment type, quartz veins and granitic rocks with
denite mineralization, and spodumene-beryl
atites. [Seven mining properties are describ-
-Auth, p. 1-2, 7.

8. McPhee, Duncan S. PRELIMINARY RE-
T ON AGUANISH AREA, SAGUENAY ELECTOR-
ISTRICT: Quebec, Dept. Mines, Prelim. Rept.
03, 6 p., fold. geol. map (Prelim. Map no.
, scale 1:63,360, 1959, 2 refs.

e Aguanish area, mapped in summer 1958,
s about 215 sq. mi. and is bounded on the S. by
. Lawrence River and on the N. by $50^{\circ}30'$N.
eastern and western boundaries are $61^{\circ}55'$ and
'W. respectively. All the consolidated rocks
recambrian. Excluding large sections in the
ern part of the area where little information on
basement is available, granitic, highly metamor-
ed, and complexly folded rocks predominate.
complex is intruded by several irregular bodies
assive granite and a few small sills and stocks
bbro. Pegmatite dikes and sills cut all the rocks
n several places have formed extensive tabular
es. Two major folds were outlined. No mineral
rrences of economic importance were found, but
ralization in a variety of sedimentary and igne-
ocks indicates that further attention is warrant-
-A. C. Sangree.

9. Murphy, Daniel L. PRELIMINARY RE-
T ON THE CARHEIL AND LE GENTILHOMME
ES AREA, SAGUENAY ELECTORAL DISTRICT:
ec, Dept. Mines, Prelim. Rept. no. 412, 10 p.,
geol. map (Prelim. Map no. 1314), scale
360, 1960, ref.

he area ($52^{\circ}30'$-$52^{\circ}45'$N. $66^{\circ}45'$-$67^{\circ}15'$W.), map-
n summer 1959, covers about 310 sq. mi., about
mi. NNW. of Sept-Iles. Pleistocene and Recent
sits cover about 60% of the land surface. Con-
ated rocks are Precambrian. Paragneisses,
schists, and metasedimentary Fe formation units
abundant and appear to be metamorphic equiva-
of relatively unmetamorphosed Labrador trough
s to the N. A few widely scattered exposures
phibolite(?) within the gneisses are apparently
ed from basic intrusive rocks. Nearly all the
morphic rocks have been permeated by granitic
rial. The youngest bedrock is relatively un-
ed gabbroic (and ultrabasic?) to syenitic intru-
complex.
xide-type ironstone is thin and discontinuous in
region. Several localities in the western half
e area are held under claim by various compa-
. Occurrences of sulfides, graphite, and sand
gravel are noted.--A. C. Sangree.

2-1080. Pollock, Donald W. PRELIMINARY REPORT ON ROCHEBLAVE AREA, ELECTORAL DISTRICTS OF PAPINEAU AND LABELLE: Quebec, Dept. Mines, Prelim. Rept. no. 408, 8 p., fold. geol. map (Prelim. Map no. 1312), scale 1:63,360, 1959.

The Rocheblave area (46°-$46^{\circ}15'$N. $75^{\circ}15'$-$75^{\circ}30'$W.), mapped in summer 1959, occupies 207 sq. mi. A central core composed of multiple sills of green syenite is surrounded by complexly folded paragneisses of the Grenville(?) series. These paragneisses are, in order of abundance: quartzite, biotite gneiss, hornblende-biotite gneiss, hornblende-andesine gneiss, crystalline limestone with metamorphic pyroxenite and diopside-tremolite schist, rusty-weathering gneiss, and amphibolite. Intrusive rocks other than the green syenite include gabbro and granites, as well as diabase and pegmatite dikes. Mixed gneisses, involving the Grenville and later intrusive rocks have been developed in places.--Auth., p. 1-2.

Minor sulfide occurrences were noted. Some of the larger quartzite areas may have sections pure enough for commercial exploitation.

2-1081. Van Loan, Paul R. PRELIMINARY REPORT ON THE SOUTHEAST QUARTER OF FIEDMONT TOWNSHIP, ABITIBI-EAST ELECTORAL DISTRICT: Quebec, Dept. Mines, Prelim. Rept. no. 410, 10 p., fold. geol. map (Prelim. Map no. 1311), scale 1:12,000, 1959, 3 refs.

The area ($48^{\circ}17'$-$48^{\circ}21'$N. $77^{\circ}34'$-$77^{\circ}40'$W.), mapped in summer 1958, covers about 25 sq. mi. All rocks are Precambrian. The oldest and most abundant are metamorphosed Keewatin-type acidic to basic volcanics which have been intruded by various types of plutonic rocks including amphibolite, peridotite, quartz diorite, granodiorite, albite granite, feldspar porphyry, and quartz diabase.

Glacial and postglacial unconsolidated deposits are very abundant, with morainal hills being particularly notable in Ranges II and III, along the W. bank of Courville River. Glaciofluvial deposits of sandy material form what appears to be a series of kames near the highway in Range IV, and postglacial lacustrine clays are present throughout the area wherever the land is low enough to have been submerged beneath the waters of the former Barlow-Ojibway lake.

Four different types of metallic mineralization were recognized in the area. These are: 1) an occurrence of auriferous massive sphalerite in acidic volcanic rocks, 2) a series of molybdenite-bearing pegmatitic quartz veins, 3) 2 small occurrences of pyrrhotite in basic volcanic rocks, and 4) disseminated pyrite in several outcrops of acidic tuff and rhyolite.--Auth., p. 2, 9.

2-1082. Coats, Robert R. GEOLOGIC RECONNAISSANCE OF SEMISOPOCHNOI ISLAND, WESTERN ALEUTIAN ISLANDS, ALASKA: U.S. Geol. Survey, Bull. 1028-0, p. 477-519, 14 illus., 2 maps (1 col. geol. map in pocket, scale approx. 1 in. to 1 mi.), 3 diags., table, 1959, 27 refs.

Semisopochnoi Island, the largest of the young volcanic islands of the western Aleutians, is the easternmost of the Rat Island group, and is near the southern extremity of the great Aleutian arc. The island consists entirely of volcanic rocks, and sediments derived from them, of probable Pleistocene and Recent age. It is a large shield-shaped basaltic volcano, with parasitic cones of andesite and basalt.

The higher, central part, which once supported extensive glaciers, subsequently collapsed to form an elliptical caldera almost 5 mi. in greatest width. The collapse was attended and, at least in part, caused by the extrusion in the form of glowing clouds of large volumes of pale-gray dacitic pumice and ash. In most of the present valleys there are thick deposits of this pumice and ash, but in the parts of the island that were sheltered from this flood of hot, gas-charged pumice and ash there are only thin layers. After the collapse, eruptions of basalt and basaltic pyroclastic material took place in the caldera. Recent composite cones of basaltic composition, 2 large and 1 small, have erupted intermittently and have built up domes of lava, the largest of which is nearly 3,000 ft. high. The lava flows emitted from these cones have nearly filled the caldera floor, and cover a considerable area in the southeastern quarter of the island.

The rocks are generally poor in phenocrysts; the principal minerals are intermediate to calcic plagioclase, olivine, hypersthene, clinopyroxene, usually augite in the phenocrysts and augite or pigeonite in the groundmass, magnetite or ilmenite, apatite, quartz, and orthoclase. Hornblende is present only in the dacitic tuff erupted at the time of the formation of the caldera. The analyses indicate that the alkali-lime index is about 59, hence the province is calcalkaline, thus differing perceptibly in this respect from other Aleutian volcanoes from which extensive rock series have been analyzed. The relations of the oxides make it evident that the rocks of Semisopochnoi are somewhat enriched in Fe in the intermediate composition range, thus departing slightly in this regard from the normal basalt-andesite-dacite sequence. The content of a few of the minor constituents in the rocks of Semisopochnoi differs significantly from that of the rocks of other western Aleutian islands.--Auth.

2-1083. Lewis, Richard Q., Willis H. Nelson, and Howard A. Powers. GEOLOGY OF RAT ISLAND, ALEUTIAN ISLANDS, ALASKA: U.S. Geol. Survey, Bull. 1028-Q, p. 555-562, 2 maps (geol. map in pocket, scale 1:63,360), 1960, 2 refs.

Rat Island is formed of volcanic rocks, conglomerate, and sandstone that are divided into 2 stratigraphic units. The older, Rat formation, consists of porphyritic hornblende andesite lava flows and breccias, and conglomerate derived from them. The younger, Gunners Cove formation, contains tuffs and lavas of basalt, sandstone, and conglomerate composed largely of basaltic fragments, and some hornblende andesite similar to that of the Rat formation. Marine conglomerate interbedded in the basalts contains a small fauna of middle Tertiary age. The older andesitic rocks, and, to a lesser extent the basaltic rocks, have been chemically altered and pyritized along WNW.-trending fracture zones. Normal high-angle faults are abundant and strike generally WNW. or within a few degrees of N.; and the few dikes, all of basalt, strike N. Zones of altered and mineralized rock seem to trend WNW.

The physiographic forms are all those of erosion-marine platforms and cliffs that are greatly to slightly dissected by stream erosion, and are modified by glaciation. An extensive emerged marine platform, slightly dissected and glaciated, rises to an inland altitude of about 180 ft. Much of the sea cliff is not attacked by present wave action, being separated from the active shoreline by emerged boulder beaches and rock benches.--Auth.

2-1084. Powers, Howard A., Robert R. Coats, and Willis H. Nelson. GEOLOGY AND SUBMARIN PHYSIOGRAPHY OF AMCHITKA ISLAND, ALASKA. U.S. Geol. Survey, Bull. 1028-P, p. 521-554, 2 maps (geol. map in pocket), profile, table, 1960, 1 refs.

Amchitka Island is the exposed part of a segmen of the Aleutian Ridge just W. of the southernmost part of the Aleutian arc. It has been disturbed by faulting, differentially uplifted, and dissected by marine, stream, and glacial erosion. The oldest rocks, the Amchitka formation, are volcanic ash, tuff, breccia, and lava flows generally of andesitic composition, apparently erupted and emplaced unde the ocean. These rocks were deformed, uplifted, and subjected to erosion before and during depositi of the interbedded conglomerate, basaltic breccia, and tuff of the Banjo Point formation. A meager Banjo Point fauna is Oligocene or possibly early Mi cene in age. Rocks of both these formations were intruded by small bodies of quartz diorite.

Flows of feldspathic basalt and andesite, interbe ded with marine conglomerate in the lower part and subaerial in the upper part, make up the next younge formation, the Chitka Point formation. In places, rocks of the lower part of the formation were deform ed before eruption of the flows of the upper part. Th subaerial lava flows were submerged at least 600 ft. and possibly 1,100 ft. Erosion reduced the mass to a surface of low relief, possibly a submarine shoal now represented by an erosion surface at an altitude of about 1,100 ft. Marine sand and cobble conglomerate, perhaps formed during this erosion, are now exposed at altitudes of up to 600 ft.

Uplift of at least 500 ft. and possibly more than 1,100 ft. took place differentially and spasmodically during late Tertiary and Quaternary time. A wave-cut platform (perhaps cut during a time of high interglacial sea level) forms a partly dissected plateau between 700 and 900 ft. in altitude. A younger abandoned sea cliff, whose base is at an altitude of 240 ft., and a beach deposit, whose top is at 135 ft., are inferred to be structurally dislocated remnants of shoreline features of a late Pleistocene interglacial high sea level, as the fauna of the beach deposit is characteristic of warmer water than now surrounds the island. Movement along faults bounding the Constantine Harbor graben occurred during deposition o late glacial deposits.

Stream-cut ridge and valley topography, modified by glacial action, extends below sea level. The ridges terminate in a line of cliffs at the edge of a plane surface at a depth of about 165 ft. This surfac slopes seaward and joins a wide, much flatter bench that extends to the edge of the continental shelf. Both surfaces are interpreted as wave-cut benches associated with shorelines of lower late-glacial sea level The deeper bench is block faulted in the eastern part but the minus 165-ft. bench is not disturbed by these faults.

Sea cliffs cut by postglacial marine erosion have been abandoned by a relative lowering of sea level of 6 or 8 ft. that took place before Aleut settlement mor than 4,000 years ago.--Auth.

2-1085. Fort Smith Geological Society. GUIDE BOOK. FIRST REGIONAL FIELD CONFERENCE. WESTERN PORTION OF ARKANSAS VALLEY BASIN APRIL 30-MAY 2, 1959: 100 p., 8 illus., 14 maps (2 in pocket), 6 secs., 3 diags., 2 graphs, 2 logs (in pocket), [Fort Smith?], 1959, refs.

This guidebook contains papers on geology of var-

areas in the Arkansas Valley, especially of
s with known gas fields. The papers and road
are listed below. Those with capitalized titles
bstracted separately in the order in which they
ar in the guidebook.
ouser, Charles W. The Arkansas Valley - A
ogical Land of Opportunity, p. 1-2.
anner, William F. GEOMORPHOLOGY OF
RESENTATIVE AREAS, p. 3-6.
analp, Roger N. DRILLING AND LOGGING
HODS IN THE ARKANSAS VALLEY, p. 7-9.
ark, Joe M. The Geology of White Oak Gas
, p. 10-13.
ock, Floyd W. Geology of Cecil Gas Field, p.
7.
analp, Roger N. GENERAL GEOLOGY OF THE
NA GAS FIELD, p. 18-22.
rtlett, Charles S., Jr. Washburn Anticline and
ciated Gas Fields, Sebastian, Franklin and
n Counties, Arkansas, p. 24-27.
uinn, James Harrison. BURIED STRUCTURES
THE BOSTON MOUNTAINS, p. 29-51.
ckson, Kern C. THE GEOLOGY OF SOUTH-
TERN WASHINGTON COUNTY, ARKANSAS, p.
3.
D LOGS
aible, C., and J. Cavallas. Road Log 1st Day
eld Trip, p. 75-78.
rtlett, Charles S., Jr. Road Log 2nd Day of
Trip, p. 79-96.
TRIP LOGS
de Trip A. Savanna Sandstone Section, Charles-
Arkansas, p. 97-98.
de Trip B. Ranger Anticline Limestone Out-
p. 99-100.

**86. Tanner, William F. GEOMORPHOLOGY
EPRESENTATIVE AREAS (In: Fort Smith Geo-
al Society. Guidebook. First Regional Field
erence...1959: p. 3-6, 3 maps, 2 graphs, [Fort
h?], 1959) 3 refs.**

hree areas, each covering 100 to 400 sq. mi. are
en to represent the Boston Mountains, the N.
of the Ouachita Mountains, and an inner valley
e Ouachita Mountains. They can be described,
oximately, as areas in middle to late maturity.
igraphic and structural control is shown to be
rtant. Structural control is also demonstrated
g part of the Arkansas River.--Auth.

**87. Planalp, Roger N. DRILLING AND LOG-
METHODS IN THE ARKANSAS VALLEY (In:
Smith Geological Society. Guidebook. First
onal Field Conference...1959: p. 7-9, table,
Smith?], 1959)**

rilling for natural gas by cable tool rigs has been
ied on in the Arkansas Valley basin since 1902.
ing techniques have remained basically un-
ged until the success of rotary air drilling in
. Rotary mud drilling has not been practical,
primarily to very low penetration rates. Cable
, rotary air-gas, and a combination of the two
ods are commonly used today. The basic prob-
of drilling in the valley is the handling of water
s and economic penetration rates.
able tool drilling techniques in the Arkansas Val-
provide difficult logging problems. Different
s of logs available for various hole conditions are
d. The advantage of the cable tool and rotary
gas open hole helps compensate for the frequent
of adequate logs, as shows are positive.--Auth.

2-1088. Planalp, Roger N. GENERAL GEOLOGY OF THE AETNA GAS FIELD (In: Fort Smith Geological Society. Guidebook. First Regional Field Conference...1959: p. 18-22, 2 maps, table, [Fort Smith?], 1959)

The Aetna gas field is in Township 8 N., Range 26, 27, and 28 W., Franklin and Logan counties [Arkansas]. Old shallow wells found commercial production and salt water. Athletic Mining and Smelting Company's #1 Mantooth was drilled to 5,700 ft. in 1954 and completed as a triple completion gas well. Majority interest in the Aetna field is held by Athletic Mining and Smelting Company, Continental Oil Company, Carter Oil Company, and Stephens Production Company.

Eight wells have been drilled to date with 18 completed zones. Total open flow potential is 90,800 MCF.

The Aetna anticline trends E.-W. and is faulted by major and minor faulting. Closure is formed by the anticline and by faulting. Atoka shales, Hartshorne sandstone, McAlester shale, Savanna sandstone, and Boggy shale [all Pennsylvanian] are exposed on the surface. The Aetna anticline presents many trapping combinations for gas accumulation. A high structural position is not necessary for gas accumulation. Flank wells will cost considerably more to drill and possibly salt water will be encountered in some pay sands.--Auth.

2-1089. Quinn, James Harrison. BURIED STRUCTURES OF THE BOSTON MOUNTAINS (In: Fort Smith Geological Society. Guidebook. First Regional Field Conference...1959: p. 29-51, 4 maps, sec., 2 diags., [Fort Smith?], 1959) 12 refs.

The structural fabric of the Arkansas Ozark region and most probably the Arkansas Valley region as well is the product of: 1) development of N.-S.-trending arches at the end of Boone time forming embayments; 2) development of NE.-trending compound folds in Morrow time with major subsidence of the western embayment in Hale time; 3) development of E.-W.-trending monoclines and faults, and NE.-trending faults in lower Atokan time; 4) E.-W.-trending folds developed in post-lower Pennsylvanian, exact time unknown, possibly with additional movement on faults; 5) possible reverse movement on E.-W. faults in late Pleistocene time in response to differential unloading.

The structural fabric outlined above has locally controlled sedimentation (with exception of 5 and 6).

The structural fabric is not readily traceable on the surface of the Atoka because of burial. The arches are identifiable on either side of the valley because of the alignment of structural highs. The secondary structure of the western embayment is identifiable by: 1) sags and swells on E.-W. folds; 2) arcuate deviations in the trends of E.-W. folds; 3) deflection and pattern of drainage; 4) synclinal structures plunging SE. (most commonly found) SW., NW., and NE.; 5) closed contours with N.-S. and E.-W. extensions (cross-shaped); 6) 'abnormal' amounts of clastic or oölitic limestone in the subsurface section.--Auth. concl.

2-1090. Jackson, Kern C. THE GEOLOGY OF SOUTHWESTERN WASHINGTON COUNTY, ARKANSAS (In: Fort Smith Geological Society. Guidebook. First Regional Field Conference...1959: p. 52-73, 4 maps (1 in pocket), [Fort Smith?], 1959) 45 refs.

The stratigraphy and structure of SW. Washington

County, Arkansas, is very illuminating to the geologic development of the Boston Mountain and Arkansas Valley provinces during Carboniferous times. Three major structural elements are identifiable in the area. Largest and oldest is the State-Line arch along the Arkansas-Oklahoma border and its associated trough to the E. Stratigraphic evidence indicates that the earliest marked subsidence of this trough took place in Pitkin [Mississippian] time. This is evidenced by thickness changes in the Pitkin and by an interpreted onlap of the Pitkin on the arch. Subsidence of the trough accentuating the arch continued through all the younger formations.

The second period of deformation is shown by a series of NE.-trending asymmetrical folds. These folds developed during Bloyd [Pennsylvanian] time and affect all older rocks. They can be traced up into the basal Atoka [Pennsylvanian] sediments but die out and are buried by the main mass of the Atoka sediments. A Bloyd age for the deformation can be demonstrated by systematic thinning of the Bloyd sediments over the anticlines and thickening in the synclines. Associated with the folds are a few faults one of which occurs in this area. These faults are post-Brentwood in age and seem to be related to tension along the crests of the folds.

The last period of deformation is represented in the area by a series of E.-W. trending asymmetrical folds resulting from compression from the S. during the culmination of the Ouachita orogeny. All of the formations of the area have been affected by this deformation. The intersection of the E.-W. anticlines with the NE. anticlines is of particular interest because it results in the development of a local domal structure which may serve as a trap for the accumulation of gas.--Auth.

2-1091. Johnson, Ross B. **GEOLOGY OF THE HUERFANO PARK AREA, HUERFANO AND CUSTER COUNTIES, COLORADO: U.S. Geol. Survey, Bull. 1071-D, p. 87-119, 3 illus., 2 maps (col. geol. map in pocket, scale 1:31,680), 4 secs. (in pocket), 1959, 55 refs.**

The Huerfano Park area comprises about 240 sq. mi. in the extreme northern part of the Raton basin, and about 50 sq. mi. to the N. on the western slope of the Wet Mountains and on the eastern slope of the Sangre de Cristo Mountains. This small area displays both the compressional effects on sedimentary rocks created by intense eastward thrusting in the Sangre de Cristo Mountains on the W. and vertical uplifting of the Wet Mountains on the E. during the Laramide revolution.

A thick sequence of sedimentary rocks of Paleozoic, Mesozoic, and Cenozoic age is preserved in the area. These strata consist of unnamed marine rocks of Pennsylvanian age; the Sangre de Cristo formation of Pennsylvanian and Permian age; the Entrada sandstone and the Morrison formation of Jurassic age; the Purgatoire formation, the Dakota sandstone, the Graneros shale, the Greenhorn limestone, the Carlile shale, the Niobrara formation, and the Pierre shale of Cretaceous age; the Poison Canyon formation of Paleocene age; the Cuchara and Huerfano formations of Eocene age; the Farisita conglomerate of probable Oligocene age; and the Devils Hole formation of probable Miocene age.

Sills, dikes, plugs, and a laccolith were intruded into the sedimentary rocks during at least 2 periods of intrusive activity in Eocene time. Late Tertiary and Quaternary volcanic activity took place in the Wet Mountains E. and NE. of the Huerfano Park area.

The ancestral Rocky Mountains and Wet Mounta
were above sea level during a large part of the Pa
zoic era and supplied sediments to neighboring ba
during Pennsylvanian and Permian time. Jurassic
and Cretaceous seas covered the Huerfano Park ar
several times. The Laramide revolution began in
this region in late Montana (Pierre) time with epei
rogenic movements in the mountainous area W. of
the Raton basin. These epeirogenic movements w
followed by at least 7 distinct orogenic episodes,
shown by 5 angular unconformities and by the presence of coarse clastic material and fresh feldspar
in some of the Mesozoic and early Cenozoic rocks
Auth.

2-1092. Wanek, Alexander A. **GEOLOGY AND
FUEL RESOURCES OF THE MESA VERDE AREA,
MONTEZUMA AND LA PLATA COUNTIES, COLO
ADO: U.S. Geol. Survey, Bull. 1072-M, p. 667-
20 illus., 2 maps (col. geol. map in pocket, scale
1:63,360), 4 secs. (in pocket), 7 tables, 1959, 31**

The Mesa Verde area includes about 520 sq. mi
of the northwestern part of the San Juan basin in
Montezuma and La Plata counties, Colorado. The
area lies within the Colorado Plateau province and
immediately adjacent to the La Plata Mountains, o
of the westernmost ranges in the Rocky Mountain s
tem. Elevations in the area range from about 5,0
to about 8,600 ft. above sea level. Mesa Verde is
the most conspicuous topographic feature and incl
Mesa Verde National Park. The major part of the
area lies within the Ute Mountain Indian Reservati
and is sparsely populated.

The exposed rocks in the area are of Late Cret
ceous age. The Dakota sandstone crops out in the
northwestern part of the area, and the overlying M
cos shale of marine origin is exposed widely along
the edge of Mesa Verde. The Mesaverde group co
sisting of the marine Point Lookout sandstone at th
base, the middle coal-bearing Menefee formation,
and the marine Cliff House sandstone at the top, o
lies the Mancos shale. The Point Lookout sandsto
is younger in the northern than in the southern pa
of the area. It rises stratigraphically northward
intertonguing at its base with the Mancos shale. T
Menefee formation is a northwestward-tapering
wedge; it intertongues at its base with the top of th
Point Lookout sandstone and at its top with the bas
of the overlying Cliff House sandstone. The mari
Cliff House sandstone is older in the northern tha
in the southern part of the area; it rises stratigra
ically to the S. by intertonguing at its base with th
Menefee formation. The marine Point Lookout an
Cliff House sandstones were deposited as a succes
sion of great overlapping lenses; they enclose the
wedge of continental coal-bearing sedimentary ro
of the Menefee. Overlying the Cliff House sandst
and separated from it by an erosional surface, ar
small deposits of unconsolidated gravels of Tertiary(?) age. Several levels of gravel terraces of
late Recent origin lie in the Mancos Valley.

The Mesa Verde area lies wholly within the Fo
Corners platform subdivision of the San Juan basi
The rocks are gently folded into a shallow synclin
that plunges to the S. This structure is flanked o
the E. by Barker dome, on the W. by the Sleeping
Ute Mountain uplift, and on the N. by the Dolores
plateau. The rocks are broken by a few normal
faults of little displacement.

The coal is of bituminous rank and of good gra
but the beds are lenticular and generally thin, although some are as much as 4 ft. thick. Coal be

of commercial importance occur in the lower coal member of the Menefee formation and to a lesser extent in the upper coal member of that formation. Very little coal has been mined commercially in the area.

Gas is produced from the Dakota sandstone in the Point Lookout field; on the adjacent Barker dome structure it is produced from both the Dakota sandstone and from the Paradox member of the Hermosa formation of Pennsylvanian age. In the subsurface in the intertonguing relationship between the Mancos shale and the Point Lookout sandstone may prove an adequate stratigraphic trap for the accumulation of oil and gas. Systematic drilling in the area may show good oil and gas possibilities in the Dakota sandstone and in strata of Pennsylvanian age.--Auth.

2-1093. Kansas Geological Society. GUIDEBOOK. TWENTY-FOURTH FIELD CONFERENCE. SOUTH-CENTRAL KANSAS: 136 p., 20 illus., 52 maps (3 in pocket), 36 secs. (7 in pocket), 4 profiles, 3 diags., 2 graphs, log, 2 tables, [Wichita?], Oct. 1959, refs.

This guidebook was prepared in cooperation with the State Geological Survey of Kansas for the American Association of Petroleum Geologists, Midcontinent Regional Meeting, Wichita, Oct. 29-30, 1959.

The field trips have been designed for the study of 2 specific geologic problems, widely different in nature and unusually well displayed in the areas to be visited. Field Trip No. 1 is built primarily around visits to salt mines at Lyons and Hutchinson. Structure and flowage in the salt is well illustrated at Lyons. A unique set of conditions has resulted in visible flowage of salt as early as 30 days after opening of a room, and buckling and fracturing of the floor as a result of flowage often begins before mining is complete. Other interesting features of this trip include observation of a full-scale test run by the Oak Ridge National Laboratory on the disposal of simulated radioactive waste in the salt, and a visit to a Cities Service L. P. G. storage facility near Hutchinson. The route of the trip is over relatively flat plains country covered mostly by Pleistocene deposits, although several fair outcrops of Wellington shale and overlying Ninnescah shale (both Permian in age) may be seen, and one of the few good outcrops of Stone Corral dolomite (Sumner group, Leonardian stage, Permian) lies on the route. A considerable portion of the trip will be across the Equus beds (Pleistocene) which are famous as one of the great aquifers of the Midcontinent region.

Although Field Trip No. 2 is of interest primarily to those especially interested in sedimentology, the route passes a large number of very good outcrops representing virtually all of the formations from the Winfield limestone (Chase group, Wolfcampian stage of the Permian) down to the Topeka limestone (Shawnee group, Virgilian stage of the Pennsylvanian).--From introd. by W. S. Johns.

The papers and road logs are listed below in the order in which they appear in the guidebook.

Jewett, John M. History of Oil and Gas Developments in Eastern Kansas, p. 10-12.

Road Log, Wednesday, October 28, Field Trip No. 1, p. 19-33.

Dellwig, Louis F., and James D. Snyder. Plastic Flow in Hutchinson Salt Member in Mines at Lyons, Kansas, p. 35-41.

Road Log, Saturday, October 31, Field Trip No. 2, p. 43-67.

Imbrie, John, Léo Laporte, and Daniel F. Merriam. Beattie Limestone Facies and their Bearing on Cyclical Sedimentation Theory, p. 69-78.

Frye, John C., and A. Byron Leonard. Flint Hills Physiography, p. 79-85.

Goebel, Edwin D. Oil and Gas Fields of South-Central Kansas, p. 86-93.

Parkhurst, Robert W. Surface to Subsurface Correlation of Lansing-Kansas City Rocks (Pennsylvanian) in Kansas, p. 94-100.

Schulte, George S. The Cottage Grove and Noxie Sandstones ("Layton") in South-Central Kansas, p. 101-106.

McManus, Dean A. Stratigraphy of Lower Pennsylvanian Rocks in Northeastern Hugoton Embayment, p. 107-115.

Shenkel, Claude W., Jr. Geology of the Abilene Anticline in Kansas, p. 116-128.

Merriam, Daniel F. Upper Pennsylvanian and Lower Permian Rocks in Northeastern Kansas, p. 129-136.

2-1094. Wehrenberg, John P., ed. GUIDEBOOK TO FIELD TRIPS. THE GEOLOGICAL SOCIETY OF AMERICA ROCKY MOUNTAIN SECTION. TWELFTH ANNUAL MEETING. MONTANA STATE UNIVERSITY, MISSOULA, MONTANA, MAY 14-17, 1959: 85 p., 6 maps [Missoula?], 1959, refs.

The geology of western Montana is as complex and interesting to workers in a wide variety of fields as any in the western states, yet after 60 years, probably less is known about it than any other area of comparable size. Fortunately, the early work (up to the last 10 years) in this region by such men as Lindgren, Calkins, Emmons, Alden, Pardee, Ross, Clapp, and Deiss has laid an exceptionally fine basis upon which present and future geologists can build. With a few exceptions, the period of broad reconnaissance is about over, and the period of revision and detailed studies is just beginning.--From ed. foreword.

The road logs and papers included are listed below in the order in which they appear in the guidebook.

ROAD LOGS

Nelson, Willis H., and J. P. Dobell. Field Trip 1; Stratigraphy of the Belt Series, p. 1-6.

Honkala, Fred. S., and John P. Wehrenberg. Field Trip 2; Drummond-Helmville-Ovando Area, with Emphasis on Post-Precambrian Geology, p. 7-24.

Honkala, Fred S., Kenneth Soward, and John P. Wehrenberg. Field Trip 3; Glacial Geology of the Flathead Valley and Environs, p. 25-36.

Wehrenberg, John P. Field Trip 4; Northern Bitterroot Range and Idaho Batholith Border Facies, p. 37-43.

PAPERS

Leischner, Lyle M. The Lower Belt Series of Western Montana, p. 44-46.

Nelson, Willis H. Stratigraphy of the Newland Limestone and the Missoula Group of the Belt Series, p. 47-57.

Tidyman, Thomas. Paleozoic Stratigraphy of the Nimrod-Drummond Area, p. 58-63.

Honkala, Fred S. Mesozoic and Cenozoic, p. 64-65.

de la Montagne, J. Comments on Late Pleistocene Features of Western Montana, p. 66-70.

McMannis, W. J. Salient Tectonic Features of Western Montana, p. 72-75.

Anderson, R. E., and D. Hutchison. Igneous and Metamorphic Rocks of Western Montana, p. 76-82.

Parker, Ronald C. Mineral Production, p. 83-85.

2-1095. New Mexico Geological Society. TENTH FIELD CONFERENCE, OCTOBER 15, 16, AND 17, 1959. GUIDEBOOK OF WEST-CENTRAL NEW MEXICO, ed. by James E. Weir, Jr., and Elmer H. Baltz: 162 p., illus., maps, secs., (1 in pocket), diags. (3 in pocket), graph, table, [Socorro?] 1959, refs.

The Tenth Annual Field Conference of the New Mexico Geological Society traverses a region which has received little attention from geologists. Mining in the mountains S. of Magdalena has been an industry of some note for decades, but only recently has the petroleum geologists interest in W.-central New Mexico been aroused. The structure of most of this area is simple. Broad folds typical of the Colorado Plateau province account for the main part of the structural deformation in the region. The eastern part of the field-trip area is characterized by complex block faulting and, locally, overthrusting in the western margin of the Rio Grande trough. Rocks exposed in the field-trip area range in age from Precambrian to Recent and consist of sedimentary, metamorphic, intrusive igneous, and volcanic types.

In the subsurface somewhere near the southern part of the field-trip area a thick wedge of Cambrian, Ordovician, Silurian, and Devonian rocks present in southern New Mexico pinches out. These rocks are overlapped by Pennsylvanian rocks which thin northward onto an ancient positive area - the ancestral Zuni uplift. Permian rocks are present throughout most of the region and are overlain by Triassic rocks. A thick sequence of Jurassic rocks present in the northern part of the area wedges out to the S. Cretaceous rocks, deposited during transgressions and regressions of a great seaway, crop out over much of the region. Tertiary sedimentary and volcanic rocks of considerable thickness blanket the southernmost part of the area, and basalt flows of Tertiary and Quaternary age can be seen from almost any hill.--From Foreword.

Introductory material includes a nomenclature chart for the field trip and adjacent areas, discussion of possible future field conferences, and a schedule and route map for the conference. Then follow 4 road logs: 1) Socorro to Grants, via Magdalena, Kelly, Rio Salado, Red Lake, and Acoma (p. 13-24); 2) Grants to Gallup, via El Morro National Monument, Ramah, Pinehaven, and McGaffey (p. 25-36); 3) Gallup to Socorro, via Zuni Pueblo, Fence Lake, Salt Lake, and Quemado (p. 37-46); 4) Ramah to McGaffey, via Ruin Canyon and Page (p. 47-50). Twenty-four references are cited in connection with the road logs.

Nine papers on stratigraphy, 2 on general geology, and 3 on economic geology are abstracted separately below in the order in which they appear in the guidebook. Following the technical papers are 2 of general interest: El Morro - New Mexico's Historic Headland, by Edison P. Lohr; Indians of West-Central New Mexico, by Sidney R. Ash. Eighteen abstracts of technical papers presented at the 13th Annual Meeting of the Society, Albuquerque, Apr. 24, 1959, complete the guidebook.

2-1096. Armstrong, Augustus K. MISSISSIPPIAN STRATA ON THE EAST SIDE OF THE DATIL PLATEAU (*In*: New Mexico Geological Society. Tenth Field Conference...1959. Guidebook...: p. 52-56, 3 secs., [Socorro?], 1959) 9 refs.

Mississippian rocks of W.-central New Mexico are divided into the Caloso and Kelly formations. The Caloso formation rests on peneplained Precambrian rocks, appears, on the basis of 15 species, to be of earliest Osage age, and occurs in the Coyote Hills and in the Lemitar, Ladron, Magdalena, and Manzano mountains. Basal beds are of transgressive quartz sandstone, graywacke, or arkose, overlain by a few feet of gray shale and nodular limestone. Upper beds, 30-40 ft. thick, are of massive cherty dolomitic limestone. The Caloso appears correlativ with the Andrecito member of the Lake Valley formation.

The Kelly formation, 10-60 ft. thick in the Magdalena, Lemitar, and Ladron mountains, is a mediu bedded cherty crinoidal limestone, and is of late Osage age, based on a fauna of more than 30 species The base is marked by a 1-in. bed of sandstone resting disconformably on the Caloso; the top is an irregular erosion surface beneath Pennsylvanian strata The lack of detrital sediments in the Kelly suggests it extended further N. prior to erosion in late Mississippian and early Pennsylvanian time.--F. E. Kottlowski.

2-1097. Kottlowski, Frank E. PENNSYLVANIAN ROCKS ON THE NORTHEAST EDGE OF THE DATIL PLATEAU (*In*: New Mexico Geological Society. Tenth Field Conference...1959. Guidebook...: p. 57-62, 2 maps, sec., [Socorro ?], 1959) 18 refs.

Measured sections and scattered oil tests suggest a reasonably thick marine Pennsylvanian sequence occurs SE. of the Zuni Mountains and probably under the volcanic rocks of the Datil plateau. Pennsylvania rocks crop out in the Magdalena Mountains, along Trout Creek, and in the mesas and ranges bordering the Rio Grande Valley. One of the thickest sections in the southwestern Ladron Mountains, contains about 2,700 ft. of Pennsylvanian strata and lies withi the Lucero basin as shown on the isopach map.

An isopach and lithofacies map of the Derry-Des Moinesian rocks shows sandy facies NE. of the Joyita Hills and SE. of the Zuni Mountains. Local limestone lenses within basal Abo redbeds of the Zuni Mountains contain chiefly Pennsylvanian fossils and suggest the ancestral Pennsylvanian-age Zuni uplift was SW. of the present Zuni Mountains.--Auth.

2-1098. STRATIGRAPHY OF THE OUTCROPPING PERMIAN ROCKS IN THE SOUTHERN PART OF THE SAN JUAN BASIN, NEW MEXICO (*In*: New Mexico Geological Society. Tenth Field Conference...1959. Guidebook...: p. 63-65, diag., [Socorro?], 1959) 6 refs.

Permian strata of the Lucero uplift consist of, in ascending order, the Abo formation, Yeso formation, Glorieta sandstone, and San Andres formation. The underlying Red Tanks member of the Madera formation may contain strata of Wolfcamp age; the member about 450 ft. thick, consists of limestone with interbeds of red siltstone and arkosic sandstone.

The Abo formation, 800-900 ft. thick, consists of brownish-red sandstone and siltstone, and contains the *Supaia* flora in its upper beds. The Yeso formation is divided into the lower Meseta Blanca sandstone, 250 ft. of red sandstone, and the upper Los Vallos member, about 1,000 ft. of siltstone and sandstone interbedded with dolomite and gypsum. Above is the light-gray Glorieta sandstone, 200-225 ft. thick which interfingers upward into the San Andres limestone, a 325-350-ft. sequence of dolomitic limestone gypsum, and silty sandstone. Southward thinning of the Glorieta sandstone corresponds with southward thickening of the San Andres limestone.

Permian strata and, locally, rocks of possible Pennsylvanian age are disconformable on the Precambrian rocks of the Zuni Mountains. The Abo formation, 405-790 ft. thick, consists of brownish sandstone and arkose. The Yeso formation consists of about 80 ft. of the Meseta Blanca sandstone overlain by 225-300 ft. of the San Ysidro member, chiefly sandstone with several thin limestone beds. The Glorieta sandstone is 280-300 ft. thick, whereas the San Andres limestone, its top a karsted erosion surface, is in most of the Zuni Mountains less than 100 ft. thick.-- F. E. Kottlowski.

2-1099. Cooley, Maurice E. **TRIASSIC STRATIGRAPHY IN THE STATE LINE REGION OF WEST-CENTRAL NEW MEXICO AND EAST-CENTRAL ARIZONA (In: New Mexico Geological Society. Tenth Field Conference...1959. Guidebook...: p. 66-73, 6 maps, chart, diag. (in pocket) [Socorro ?], 1959) 27 refs.**

The Triassic rocks, the Moenkopi, Chinle, and Wingate formations, rest unconformably on middle Permian strata which are beneath an erosion surface marked by well-defined channels and karst topography. The Moenkopi formation, of Lower and Middle(?) Triassic age, in ascending order, consists of he Wupatki member, a lower reddish siltstone and an upper reddish sandstone; the Moqui member, a sequence of pale brown siltstone, mudstone, silty sandstone, and gypsum; and the Holbrook member, of lower channel sandstones and upper silty sandstone and siltstone. Whereas these members do not extend more than a few miles E. of the New Mexico-Arizona state line, upper Moenkopi(?) sediments, probably post-Holbrook member and pre-Chinle in age, occur above the Permian in the Zuni Mountains area.

Pre-Chinle erosion carved a surface of considerable relief on, and locally through, the Moenkopi rocks; channels, filled by the Shinarump conglomerate member of the Chinle, are striking features of this surface in the Holbrook, St. Johns, and Sanders areas. The Shinarump member is a scattered channel-type deposit, overlain where present by the Mesa Redondo member of mudstone, siltstone, and a medial conglomeratic sandstone in the St. Johns area, and overlain by the "lower red" member of intertonguing mudstone and conglomeratic sandstone in the Defiance and Zuni areas.

Above is the Petrified Forest member, the most widespread of the Chinle members, consisting of lower grayish-blue mudstone and minor tuffaceous sandstone, the medial conglomeratic whitish Sonsela sandstone bed, and upper brownish-red mudstone and siltstone with minor limestone, tuff, and gypsum beds. The upper Owl Rock member, of pale red siltstone and greenish limestone, occurs only between Lupton and Thoreau in this area.

Near the Zuni Mountains the contact between the Chinle and the overlying Wingate sandstone is irregular and channeled. The lower Rock Point member of the Wingate, of silty sandstone, occurs in the Defiance and Zuni areas but not near St. Johns or Thoreau. The Lukachukai member, an eolian sandstone, is 300-350 ft. thick near Ft. Wingate and in the northern Defiance plateau but is not present elsewhere in the area.--F. E. Kottlowski.

2-1100. Smith, Clay T. **JURASSIC ROCKS OF THE ZUNI MOUNTAINS (In: New Mexico Geological Society. Tenth Field Conference ... 1959. Guidebook...: p. 74-80, 3 illus., chart, 2 diags. (1 in pocket), [Socorro?], 1959) 16 refs.**

Jurassic strata in the Zuni Mountains are underlain by the Lukachukai member of the Upper Triassic Wingate sandstone, and are overlain by the Upper Cretaceous Dakota sandstone. The Jurassic units, in ascending order, are the Entrada sandstone, Todilto limestone, Thoreau formation, and Morrison formation.

Only the medial silty member and upper sandy member of the Entrada occur in the Zuni Mountains; both thin southeastward and pinch out near El Morro. Gradationally between the Entrada and Thoreau formations is the thin-bedded dark-gray U-bearing Todilto limestone, 7-30 ft. thick on the N. flank of the mountains but pinching out southward.

The Thoreau formation consists of 2 parts on the N. flank where it is nearly 400 ft. thick, a lower siltstone and sandstone unit, and an upper cross-stratified cherty sandstone. On the S., the Thoreau formation, 250-300 ft. thick, is a single massive sandstone unit such as exposed at El Morro.

The Morrison formation is thick along the northern edge of the Zuni Mountains but was removed by pre-Dakota erosion along the S. flank. The basal Chavez member, of siltstone, mudstone, and sandstone, is 150-200 ft. thick. The medial Prewitt member is chiefly a massive conglomeratic sandstone. The upper U-bearing Brushy Basin member averages about 100 ft. in thickness and is a variegated siltstone and mudstone unit.--F. E. Kottlowski.

2-1101. Gadway, Keith L. **CRETACEOUS SEDIMENTS OF THE NORTH PLAINS AND ADJACENT AREAS, McKINLEY, VALENCIA, AND CATRON COUNTIES, NEW MEXICO (In: New Mexico Geological Society. Tenth Field Conference...1959. Guidebook...: p. 81-84, map, diag. (in pocket) [Socorro?], 1959) 7 refs.**

Maximum reported thickness of the Cretaceous, 2,657 ft., is on D-Cross Mountain as measured by Pike and Winchester. Cretaceous strata, in ascending order, are the Dakota sandstone, Mancos shale, lower Gallup, D-Cross tongue of the Mancos, upper Gallup, Crevasse Canyon formation, and Point Lookout sandstone.

The Dakota sandstone, tan, conglomeratic, and cross-bedded, thickens westward from zero to about 100 ft. The lower dark gray Mancos shale includes the persistent Tres Hermanos sandstones which are directly beneath a zone of Gryphaea newberryi. The lower Gallup sediments, a complex sequence of interrelated marine and nonmarine deposits do not occur progressively lower within the Mancos from Gallup southward, as suggested by Dane, Wanek, and Reeside. The D-Cross tongue of the Mancos shale thins northward from 191 ft. near Puertecito to 90 ft. N. of Grants and may pinch out westward in the western North Plains area. The upper Gallup sandstone near Gallup is lithologically correlative with the Gallego member near D-Cross Mountain, and appears to be younger northward. Upper parts of the thicker sections appear to include the sand, shales, and coal of the Crevasse Canyon formation, and above, in 2 localities, outliers of the Point Lookout sandstone.

Cretaceous deposition in this area began in early Late Cretaceous time with a marine transgression from the NE. ; general strand-line regression to the NE. occurred in latest Carlile or earliest Niobrara time with deposition of the Gallego sandstone member. Subsequent Cretaceous deposition was probably dominantly continental.--F. E. Kottlowski.

2-1102. Dane, Carle H. **HISTORICAL BACKGROUND OF THE TYPE LOCALITY OF THE TRES HERMANOS SANDSTONE MEMBER OF THE MANCOS SHALE (In: New Mexico Geological Society. Tenth Field Conference...1959. Guidebook...: p. 85-91, map, 2 secs., [Socorro?], 1959) 19 refs.**

Herrick named the Tres Hermanos sandstone [Upper Cretaceous] in 1900, noted its outcrop E. of Tres Hermanos buttes and its concentration of enormous concretions. Hunt noted the sandstone's prominent capping of mesas in the Mount Taylor area and its position as a middle persistent sandstone in the lower 350 ft. of the Mancos shale. Gryphaea newberryi is reported from the sandstone, so that the age is similar to that of the Greenhorn limestone.

The basal sandstone of Winchester's section S. of Puertecito is correlated on the basin of Gryphaea newberryi with the Tres Hermanos although Tonking had accepted this basal sandstone as the Dakota sandstone.

G. K. Gilbert, in his reconnaissance of the Alamosa Creek (Rio Salado) area in 1873, noted the sandstone unit later named the Tres Hermanos although he used different names for the topographic features.--F. E. Kottlowski.

2-1103. Willard, Max E. **TERTIARY STRATIGRAPHY OF NORTHERN CATRON COUNTY, NEW MEXICO (In: New Mexico Geological Society. Tenth Field Conference...1959. Guidebook...: p. 92-99, 8 illus., geol. map, diag., [Socorro?], 1959) 8 refs.**

Mapping of the Cenozoic rocks in Catron County and in adjoining parts of W.-central New Mexico was undertaken by geologists of the New Mexico Bureau of Mines and Mineral Resources as a contribution to the revised geologic map of New Mexico being compiled by the U. S. Geological Survey; the basic subdivisions recognized in this reconnaissance mapping will be a useful framework for subsequent detailed studies.

Along the northern edge of the area, Tertiary volcanic and sedimentary rocks rest unconformably on the Cretaceous Mesaverde group. Locally, however, as in the Magdalena Mountains and to the S. in parts of the Black Range, the lower volcanic rocks rest unconformably on Permian or Pennsylvanian strata.

The Cenozoic rocks are divisible into 6 units, some of which are present in only parts of the area: 1) basal nonvolcanic reddish sediments, the Baca formation and its apparent equivalents; 2) lower volcanic group, largely of altered greenish-black or purple basaltic andesite and andesitic pyroclastic rocks; 3) the Datil formation, consisting in large part of a lower latite facies and an upper rhyolite facies, with a lower volcanic sedimentary facies near Quemado and an upper andesite facies in the Gallo Mountains area; 4) the La Jara Peak basalts and basaltic andesites of the Bear and Mangas mountains; 5) Santa Fe group and Gila conglomerate, with local thin beds of rhyolite tuff and flows of basalt; and 6) Tertiary-Quaternary basalt flows and cinder and composite cones.

Major unconformities in most of the area are at the base of the Baca formation or below the lower volcanic group, between the lower andesites and the Datil formation, above the Datil formation and below the La Jara Peak-Mangas Mountains basaltic andesites, at the base of the Santa Fe-Gila sediments, and below the late olivine basalt eruptives.--F. E. Kottlowski & auth.

2-1104. Lochman-Balk, Christina. **LIST OF STRATIGRAPHIC NAMES USED IN NORTHWEST AN CENTRAL NEW MEXICO (In: New Mexico Geologica Society. Tenth Field Conference...1959. Guidebook...: p. 100-111, [Socorro?], 1959)**

The 104 stratigraphic units listed range from the Lake Valley and Caloso formations of early Mississippian age to the late Tertiary-Quaternary Gila conglomerate and Santa Fe group. Lexicon information for each unit includes: areal distribution, first bibliographic reference, type locality, lithologic description, thickness, age, contacts, emending or redefining descriptions of note, and production of oil and gas.

Three of these stratigraphic terms have been abandoned by the U. S. Geological Survey, and 3 others are recommended for abandonment. Listing overlapping units twice, the number of terms for eac period is as follows: Mississippian 4, Pennsylvanian 8, Permian 19, Triassic 15, Jurassic 21, Cretaceous 28, Tertiary 9, and Quaternary 2.--Auth. & F. E. Kottlowski.

2-1105. Fitzsimmons, J. Paul. **THE STRUCTURE AND GEOMORPHOLOGY OF WEST-CENTRAL NEW MEXICO (In: New Mexico Geological Society. Tenth Field Conference...1959. Guidebook...: p. 112-116 map, [Socorro?], 1959) 14 refs.**

The area is mainly in the southeastern part of the Colorado Plateau, the Datil section and part of the Navajo section, and overlaps to the E. into the Rio Grande trough. Topographic relief is nearly 7,000 ft., ranging from about 4,500 ft. altitude near Socorr to the 11,389 ft. of Mt. Taylor. Structural relief is greater, ranging from the Precambrian outcrops of the Zuni, Ladron, Socorro, and Magdalena mountain to the Cenozoic rocks that form the surface of much of W.-central New Mexico.

The structural units are: Zuni uplift, Gallup embayment, Acoma embayment, Rio Puerco fault zone, Lucero uplift, Lemitar-Socorro-Magdalena zone, Rio Grande trough, and Mogollon slope. Locally the effect of geologic structure is evident in the landscape, but elsewhere major erosion surfaces have been cut across strata with little regard to attitude of the formations.

The Zuni uplift forms the southern boundary of th San Juan basin although partly surrounded by the Gallup embayment on the W. and the Acoma embayment on the E. The Rio Puerco fault zone and Lucero uplift form the boundary between the Acoma embaymen and the Rio Grande trough, with the Lemitar-Socorr Magdalena zone bordering the trough S. of the Lucer uplift. The Mogollon slope (a structural slope) is th southern part of the Colorado Plateau, S. of the Zuni Mountains, with an indefinite southern boundary.

Regional erosional surfaces are related to 2 drai age systems, the Little Colorado River to the NW. and the Rio Grande to the E. Structural and geomor phic features are principally of Cretaceous and Ceno zoic age; uplift began in Late Cretaceous time and has continued spasmodically through the Tertiary into the Quaternary, as shown by the continuous and contemporaneous faulting, sedimentation, and volcanic activity.--F. E. Kottlowski.

2-1106. Foreman, Frederick, Kathryn H. Clisby, and Paul B. Sears. **PLIO-PLEISTOCENE SEDIMENTS AND CLIMATES OF THE SAN AUGUSTIN PLAINS, NEW MEXICO. With a discussion by C. E. Stearns (In: New Mexico Geological Society. Tenth**

Field Conference...1959: Guidebook...: p. 117-120, graph., [Socorro?], 1959) 4 refs.

The San Augustin plains is an intermontane basin, probably a graben, surrounded by highlands of Tertiary volcanic rocks. Lake San Augustin occupied the basin during late Pleistocene time. From wells drilled near the center of the present playa, almost continuous cores were obtained to a depth of 2,000 ft.

The cored sediments were divisible into 9 zones based on textural variation and degree of consolidation of the sediments. Other than fresh angular mineral grains and clay derived from volcanic rocks, authigenic calcite and analcite, calcite oolites, and ostracods are notable of certain horizons. Zone 9 (1,910-2,000 ft.) is of poorly consolidated clay and silt; zones 8-6 (950-1,910 ft.), characterized by red-brown color and graded bedding, is of coarse-grained partly consolidated sand, pebbles, and silty clay. Zones 5-3 (210-950 ft.) are of gray to black calcareous silty clay; zone 2 (47-210 ft.) is of angular sand; and zone 1 (0-47 ft.) is silty clay.

Pollen analyses show an older relict Tertiary forest below 950 ft., a semi-arid steppe community up to 470 ft., pine-spruce forest to 3.5 ft., and semi-arid alkaline scrub to the surface. Expected spruce maxima corresponding to glacial stages are not notable, the spruce curve generally increasing upward from 470 to 39 ft. (latter dated about 27,100 B. P.).

Stearns noted that a lake persisted in the basin throughout at least the last interglacial stage, that the pollen record suggests continued regional uplift, and that the Pleistocene-Pliocene boundary is probably recorded by the lithologic and pollen changes at a depth of 950 ft.-- F. E. Kottlowski.

2-1107. Wengerd, Sherman A. REGIONAL GEOLOGY AS RELATED TO THE PETROLEUM POTENTIAL OF THE LUCERO REGION, WEST-CENTRAL NEW MEXICO (In: New Mexico Geological Society. Tenth Field Conference...1959. Guidebook...: p. 121-134, 4 illus., 4 maps, secs., [Socorro?], 1959) 28 refs.

The Lucero region, a topographic basin W. of the Lucero uplift and S. and SE. of the Zuni Mountains, is underlain by a stratigraphic section ranging from 4,000 to 6,500 ft. in thickness. Local structures include about 25 anticlinal noses, structural terraces, low-closure anticlines, and high-closure faulted anticlines.

This region was part of a basin of Pennsylvanian sedimentation representing a significant widening of the central New Mexico seaway or accessway from the Paradox geosyncline on the N. to the Sonoran geosyncline on the S. This accessway, in existence between Atokan and Virgilian time, ranged from 50 to 130 mi. in width and received up to 3,000 ft. of Pennsylvanian sediments which form the Sandia and Madera formations. Pennsylvanian marine sedimentation was limited on the W. by the Zuni positive, on the E. by a long sinuous platform W. of the Estancia basin and the Pedernal positive, and on the NE. by the Penasco positive. Fine-grained clastic sediments from the Zuni upland, and medium- to coarse-grained sediments from the Penasco positive make up less than one-fourth of the Pennsylvanian section which is predominantly marine limestone and shale. The sharp downwarp of the Estancia basin to the E., as a southerly basin of the central Colorado-Sangre de Cristo seaway, resulted in entrapment of westerly moving coarse-grained clastic materials from the Pedernal uplift.

The locale of the presently existing Sandia-Manzanita-Manzano-Los Pinos tectonic alignment (of Tertiary age) seems to have been a long narrow marine platform, here named the Manzanita platform, which separated the thick clastic Pennsylvanian section of the Estancia basin from the somewhat thinner but normal basinal and shelf carbonate section of the Lucero basin.

Owing to Laramide folding and Tertiary faulting, the eastern two-thirds of the Pennsylvanian Lucero basin is buried deeply beneath the valley fill of the Rio Grande trench. The major petroleum potential of the Lucero region lies in Pennsylvanian, Permian, and Cretaceous strata in combination stratigraphic-structural traps lying at depths of 1,200 to 6,200 ft.--Auth.

2-1108. URANIUM DEPOSITS IN THE DATIL MOUNTAINS-BEAR MOUNTAINS REGION, NEW MEXICO (In: New Mexico Geological Society. Tenth Field Conference...1959. Guidebook...: p. 135-143, 3 maps, sec., diag., table, [Socorro?], 1959) 7 refs.

Small deposits of U occur in Cretaceous and Tertiary rocks along a 40-mi. belt on the N. side of the Datil, Gallinas, and Bear mountains. Known deposits are in the Baca formation (Eocene?) and the Point Lookout(?) sandstone of the Upper Cretaceous Mesaverde group, in sandstone or in shale intercalated with sandstone and usually associated with carbonaceous material and accompanied by V.

Disseminated U minerals occur in the Baca formation of the Jaralosa Canyon area. In the upper Alamosa Creek area U mineralization occurs in: 1) a basal ferruginous channel-fill sandstone of the Baca formation on the Red Basin claims; 2) a carbonaceous ferruginous sandstone near McPhaul Ranch at the contact of the Point Lookout(?) sandstone with underlying shale of the Crevasse Canyon formation; and 3) a cross-bedded sandstone of the upper part of the Point Lookout(?) sandstone within a zone of carbonaceous shale laminae, a mile N. of the McPhaul Ranch. Chemical analyses from these prospects show a range of 0.001-2.31% U.

There appears to be a relationship of the U deposits to ground-water movements as influenced by structure and stratigraphy. Structural troughs, porosity and permeability changes, and the presence of carbonaceous material all seem to have been important factors in the concentration of U. A clue to the ultimate source of the U may be the traces of U in volcanic rocks of the Datil formation of Miocene(?) age; descending meteoric waters may have leached radioactive material from the Datil formation tuffaceous rocks and deposited it in underlying rocks. The presence of eruptive centers of the Datil formation only a few miles from some of the deposits may point to a possible hydrothermal origin. At any rate, some relationship of the U deposits to volcanic rocks is suggested.--F. E. Kottlowski.

2-1109. Titley, Spencer R. GEOLOGICAL SUMMARY OF THE MAGDALENA MINING DISTRICT, SOCORRO COUNTY, NEW MEXICO (In: New Mexico Geological Society. Tenth Field Conference...1959. Guidebook...: p. 144-148, 2 maps, sec., [Socorro?], 1959) 4 refs.

The Magdalena mining district was for many years the largest producer of Pb and Zn ores in New Mexico; production to date totals about 45 million dollars.

The oldest strata are Precambrian argillites cut by Precambrian gabbro, felsite, granite, and diabase, and beveled beneath the Mississippian limestone.

Most of the large ore bodies occur in the Mississippian Kelly formation. Other Paleozoic units are the Pennsylvanian Magdalena group and overlying Permian Abo formation.

Andesite and latite breccias and tuffs overlie the Paleozoic strata, are cut by rhyolite porphyry sills and overlain by banded rhyolites. The rhyolites were intruded by monzonite and granite stocks.

Major faulting is post-Paleozoic in age and trends N.-S. with dip-slip displacement. Primary ore minerals are chiefly sphalerite, galena, and chalcopyrite; numerous oxidized ore minerals occur, including the famous botryoidal smithsonite, cerrusite, and anglesite. Practically all of the ores mined were from replacement mesothermal ore bodies in the Kelly limestone.--F. E. Kottlowski.

2-1110. Motts, Ward S., and Robert A. Gaal. GEOLOGY OF PAJARITO MOUNTAIN AREA, OTERO COUNTY, NEW MEXICO: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 1, p. 108-110, 2 maps, Jan. 1960, 2 refs.

Field investigation indicates that the crystalline rocks of the Pajarito Mountain area, S.-central New Mexico, are intrusive rocks, probably Tertiary in age, rather than Precambrian basement bedrock as was previously thought. The geological evidence supporting this position consists of the discordant relation of the crystalline rocks to the adjacent sedimentary rocks, the zonation of the crystalline rocks from granite adjacent to the sedimentary rocks into a core of syenite, contact-metamorphic phenomena in the sedimentary rocks near the contact, and the presence of limestone and sandstone xenoliths in the marginal parts of the intrusive.--I. M. Johnston.

2-1111. Geological Society of America. GUIDEBOOK FOR FIELD TRIPS, PITTSBURGH MEETING, 1959: 203 p., 9 illus., 26 maps (1 in pocket), 47 secs. (4 in pocket), 2 charts, 2 diags. (1 in pocket), 3 tables, New York, 1959, 127 refs.

The 6 field trips included in this guidebook are listed below. Each road log is preceded by an introductory section noting the objective of the trip and the general geology and mineral deposits of the region covered.

Arndt, Harold H., Richard R. Conlin, Thomas M. Kehn, John T. Miller, and Gordon H. Wood, Jr. Field Trip 1. Structure and Stratigraphy in Central Pennsylvania and the Anthracite Region, p. 1-59.

Dutcher, Russell R., John C. Ferm, Norman K. Flint, and E. G. Williams. Field Trip 2. The Pennsylvanian of Western Pennsylvania, p. 61-114.

Arkle, Thomas, Jr. Field Trip 3. Monongahela Series, Pennsylvanian System, and Washington and Greene Series, Permian System, of the Appalachian Basin, p. 115-141.

Gray, Carlyle, and Arthur A. Socolow. Field Trip 4. Mineral Deposits of Eastern Pennsylvania, p. 143-166.

Shepps, Vincent C. Field Trip 5. Glacial Geology of Northwestern Pennsylvania, p. 167-188.

Philbrick, S. S. Field Trip 6. Engineering Geology of the Pittsburgh Area, p. 189-203.

2-1112. West Texas Geological Society. GEOLOGY OF THE VAL VERDE BASIN AND FIELD TRIP GUIDEBOOK, NOVEMBER 5, 6, 7, 8, 1959: 118 p., approx. 55 illus. (3 in pocket), 19 maps (3 in pocket), 2 charts (1 in pocket), 23 secs. (2 in pocket), 2 logs, table, [Midland?] 1959, refs.

The Val Verde basin of W. Texas is one of the most promising gas and oil provinces being explored today; it also is one of the most challenging to geologist and geophysicist alike. The basin is very sparsely drilled, due largely to the great depths that must be penetrated to reach the lower Paleozoic objectives; however, the limited drilling has already resulted in the discovery of 2 prolific gas fields. The thick Paleozoic sediments that fill the basin are concealed, for the most part, beneath a thin, unconformable section of Cretaceous rocks. In some areas valuable clues to the structure of the underlying beds can be obtained through a study of the exposed Cretaceous rocks. The few Paleozoic exposures in the basin reveal much of interest to the geologist.

This book is a combination of a detailed guidebook to major points of interest in the basin and a comprehensive compilation of technical papers covering much of the current thought on this province.--E. L. Dillon.

The road logs and papers included are listed below in the order in which they appear in the guidebook.

First Day Road Log - Fort Stockton to Sanderson and Return via Puckett Gas Field, p. 7-22.

Second Day Road Log - Fort Stockton to Del Rio via Sheffield and Dryden, p. 23-46.

Third Day Road Log - Del Rio to Fort Stockton via Pandale and Sheffield, p. 47-57.

Alternate Road Log - Del Rio to "Jaws" via Devils River Canyon, p. 58-59.

Hazzard, Roy T. The Age of the Yellowish Marl above the Georgetown in Northwestern Val Verde County and Southwestern Crockett County, a Discussion, p. 60-63.

Vertrees, Charles, C. H. Atchison, and Glen L. Evans. Paleozoic Geology of the Delaware and Val Verde Basins, p. 64-73.

Flawn, Peter T. Devils River Uplift, p. 74-78.

Young, Keith. Index Fossils of the Trans-Pecos Area, p. 79-84.

Vinson, M. C. Brown-Bassett Field, Terrell County, p. 85-86.

Hester, Robert J., and R. R. Holland. Structure of the Puckett Field, Pecos County, Texas, p. 87-92.

Shock, Lorenz. Seismic Exploration of the Val Verde Basin, p. 93-95.

Williams, Harold L. Paleozoic Paleontology of the Delaware and Val Verde Basins, p. 96-97.

Patrick, Edwin D. The Pecos Country, p. 98-102.

Ammon, Walter. Conspicuous Wild Life of this Area, p. 103-105.

Ammon, Walter. Prominent Plants of the Fort Stockton-Del Rio Area, p. 106-112.

Midland County Archeological Society. Rock Shelters of the Eastern Trans-Pecos, p. 113-115.

Reese, Weiman H. Techniques of the Thumper in the Val Verde Basin, p. 116-118.

2-1113. Bissell, Harold J., ed. GEOLOGY OF THE SOUTHERN OQUIRRH MOUNTAINS AND FIVEMILE PASS - NORTHERN BOULTER MOUNTAIN AREA, TOOELE AND UTAH COUNTIES, UTAH: Utah Geol. Soc., Guidebook to the Geology of Utah, no. 14, 262 p., 10 illus., 11 maps (3 in pocket), 13 secs. (5 in pocket), 3 charts, 4 diags., 11 tables, 1959, 67 refs

This guidebook deals with the geology of the southern Oquirrh Mountains and the smaller mountains between that area and the East Tintic Mountains. Th area is 40 mi. SSW. of Salt Lake City. The mountains consist of Paleozoic strata which have been folded, offset by wrench faults, and uplifted along

Basin-and-Range normal faults... The outcrops of all the units are readily accessible for study and enable refinement of the important stratigraphic succession of the Oquirrh geosyncline. The thickness of these rocks, constituting the Oquirrh formation [Pennsylvanian], exceeds 25,000 ft. a few miles N. and E. Subdivisions of this very thick sequence have not been established previously, and the first complete set of members of the Oquirrh formation are proposed in this guidebook. --From review by J. C. Osmond (Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 1, p. 115, Jan. 1960).

Contents:

Bissell, Harold J., J. Keith Rigby, and Paul Dean Proctor. Geology of the Southern Oquirrh Mountains and Fivemile Pass - Northern Boulter Mountains Area, Tooele and Utah Counties, Utah, p. 1-8.

Stratigraphy of the Southern Oquirrh Mountains

Rigby, J. Keith. Lower Paleozoic Succession, p. 9-31.

Bissell, Harold J. Upper Paleozoic Succession, p. 37-127.

Bissell, Harold J. Mississippian System, p. 37-58.

Moyle, Richard W. Mississippian and Pennsylvanian Rocks, Manning Canyon Shale, p. 59-92.

Bissell, Harold J. Pennsylvanian System, Oquirrh Formation, p. 93-127.

Bissell, Harold J. Stratigraphy of the Fivemile Pass and North Boulter Mountains Quadrangles, p. 128-182.

Proctor, Paul Dean. Igneous Rocks of the Mercur-Ophir Area, p. 183-187.

Proctor, Paul Dean. Structural Setting of Fivemile Pass and Northern Boulter Mountains Area, p. 188-197.

Proctor, Paul Dean. Structural Geology - Broad Canyon-Fivemile Pass Areas, p. 198-226.

Rigby, J. Keith. Structural Setting of the Mercur-Ophir Areas, p. 227-229.

Rigby, J. Keith. Geomorphology, p. 231-236.

2-1114. Rigby, J. Keith, ed. **GEOLOGY OF THE STANSBURY MOUNTAINS, TOOELE COUNTY, UTAH: Utah Geol. Soc., Guidebook to the Geology of Utah, no. 13, 175 p., 13 illus., 11 maps (2 in pocket), profile, 18 secs. (9 on pl. in pocket), 6 diags., graph, table, 1958, 44 refs.**

This guidebook contains 2 papers and a road log which are concerned with the geology of the Stansbury Mountains in N.-central Utah. "A well-documented history of early and mid-Paleozoic disturbances and a well-exposed stratigraphic section of these rocks are present within the mountains. The range also offers a relatively complete Cenozoic history of the area, both structurally and geomorphically."

The papers are: "Geology of the Stansbury Mountains, Eastern Tooele County, Utah," by J. Keith Rigby (p. 1-133), and "Northern Stansbury Range and the Stansbury Formation," by Wm. Lee Stokes and Dwight E. Arnold (p. 134-149). The road log for the Utah Geological Society was prepared by J. Keith Rigby and Wm. Lee Stokes (p. 150-160).

2. GEOMORPHOLOGY

See also: Areal and Regional Geology 2-1054, 2-1086, 2-1106; Paleontology 2-1151.

2-1115. **Durham, J. Wyatt. PALAEOCLIMATES (In: Ahrens, L. H. and others, eds. Physics and Chemistry of the Earth. [V.] 3: p. 1-16, 2 maps, 4 charts, 2 graphs, New York, Pergamon Press, 1959) 48 refs.**

Considerable work in the field of paleoclimatology has been done during the past 20 years, much of it using the newer techniques. In this paper the author discusses 4 different aspects and methods of interpreting past climates in which he accepts the principle of uniformitarianism and assumes there has been no continental drift and/or no polar wandering.

Distribution of fossil floras in North America indicates that the geographic position of the continents during all the Tertiary was the same as that now existing. Flora of a subtropical type extended much further poleward in the northern hemisphere during early Tertiary and gradually retreated towards the tropics in later Tertiary until the present pattern was attained.

It was concluded that evidence from the early Tertiary marine fauna militates against any shifting of the continents since the Mesozoic and, as a corollary to this, that the N. Pole has occupied the same position as at present. The tropical zones of the oceans extended N. of 50°N. in the Eocene and gradually retreated southward during the Tertiary.

Geochemical investigations showed a temperature factor in control of the O^{18}/O^{16} depositional ratio of calcium carbonate among the common Cretaceous fossils. The study was an exploratory investigation of the potential application of the paleotemperature method. Temperature determinations were between 6° and 10°C. higher than the mean annual temperatures of the adjacent seas at the present time. This is indicative of subtropical to tropical surface marine temperatures for western Europe during the Upper Cretaceous.

The evidence for the Cretaceous and Tertiary indicates that for most of the time prior to the Pliocene the tropical zone was more widespread than now. The boundary of the tropics (during certain invervals) was at some point between 50° and 60°N. in the northern hemisphere and occupied a similar position in the southern hemisphere. Interpretation becomes more difficult in pre-Cretaceous times, but other evidence indicates that a more widespread tropical climate prevailed over much of the Paleozoic, Mesozoic, and Tertiary.--T. F. Rafter, Jr.

2-1116. **U.S. Library of Congress, Reference Dept. RUSSIAN-ENGLISH GLOSSARY AND SOVIET CLASSIFICATION OF ICE FOUND AT SEA, compiled by Boris N. Mandrovsky: 30 p., Washington, D.C., 1959, 5 refs.**

Major advances in the field of ice studies and ice reporting in recent years, accompanied by a corresponding growth in specialized ice terms (in both Russian and English) have resulted in a need for Russian-English terminology guides in this field. Contacts with Soviet scientists in the course of the International Geophysical Year work have brought the extensive Russian ice terminology and its decimal system into sharp focus. This volume is an attempt to answer this need by providing a key to Soviet ice terminology and its decimal classification system.

The volume contains 1) the Soviet decimal codes of ice classification coordinated with accepted American equivalents; 2) a Russian-English glossary of terms (covering sea ice, ice of land origin found at sea, and phenomena related to the presence of ice at sea); 3) charts of ice concentration and ice dimensions (which compare Russian, American, and international usage). In the majority of cases exact equivalents of Russian terms have been found. When no English equivalent was found, the Russian term is explained by a short descriptive phrase.--From pref.

2-1117. Vyalov, O.S. ON THE RELATIONSHIP BETWEEN CONTINENTAL-ICE MOVEMENT OF ANTARCTICA AND ITS REGIONAL STRUCTURE. Translated by Research International Associates: Internat. Geology Rev., v. 2, no. 2, p. 167-173, 2 maps, 2 secs., 2 profiles, Feb. 1960, 14 refs.

L. Gould's widely accepted scheme for the movement of continental ice in Antarctica, away from a single center, is examined. A new scheme of continental ice movement is presented, for which there are 3 major ice sheds: the western ice shed, which extends across Graham Land and the Sentinel Mountains toward Edward VII Peninsula; the central, or Gould ice shed, which extends roughly parallel to the Antarctic "horst": and the eastern, or major ice shed, situated within the ice plateau of eastern Antarctica. The basic morphologic elements of Antarctica are distinguished. The origin of the valleys which cut the great Antarctic horst is discussed briefly.--Auth.

2-1118. Chute, Newton E. GLACIAL GEOLOGY OF THE MYSTIC LAKES-FRESH POND AREA, MASSACHUSETTS: U.S. Geol. Survey, Bull. 1061-F, p. 187-216, col. geol. map (in pocket, scale 1:31,680), 9 secs. (6 in pocket), log (in pocket), 1959, 21 refs.

A study of the ground-water conditions in the vicinity of Fresh Pond Reservoir in Cambridge involves also a study of a deep sediment-filled bedrock valley that extends from the town of Wilmington southeastward to Boston harbor. Seismic traverse records and borehole logs give accurate subsurface information.

The Fresh Pond buried valley has been traced southward from the southern part of Wilmington; it underlies Mishawum Lake, the Aberjona River, the Mystic Lakes, Spy Pond, and Fresh Pond. About a mile SE. of Fresh Pond it unites with the buried valley of the Charles River which extends seaward under the northern parts of Brighton and Brookline to Old Harbor in Boston. The Fresh Pond buried valley has an inner gorge cut about 60 to 90 ft. below the floor of an older, broader valley; a rock terrace at a depth of about 80 ft. below sea level is a remnant of the floor of this older valley.

The glacial deposits exposed at the surface were deposited by the last ice sheet to cover the area; deposits of older ice sheets may exist, particularly in the buried valleys, but have not been recognized. A thin discontinuous layer of till covers the highlands bordering the buried valleys, and stratified deposits formed in a sequence predominate in the valleys. The sequence began by the deposition of kames over and around remnants of glacial ice. These were followed by the deposition of clay with some interbedded sand and gravel in a body of water that covered the lowland S. of the Mystic Lakes. Deposition of this clay in the Fresh Pond area ceased when the ice readvanced and scraped up part of the clay to form the Fresh Pond moraine. Thrust faults in overridden sand and gravel indicate that the direction of movement of the ice was about S. 30°E.

During and immediately after deposition of the moraine, more outwash sand and gravel were deposited. The northern borders of the outwash deposits mark the position of the ice front when deposition ceased. Deposition of outwash continued until most of the ice had melted from the valley of the Aberjona River, but ended while ice blocks still remained.

Clay with some interbedded sand and gravel was then deposited in a lake or marine embayment that spread over the lowland between the Fresh Pond moraine and the Mystic Lakes as the glacial ice melted. The surface of the water body probably stood about 25 to 30 ft. above the present sea level. It is not known whether the clays of the Boston basin area, including those in the vicinity of Fresh Pond, are of marine or nonmarine origin.

After the deposition of the clay, outwash was deposited as a large alluvial fan southward over the clay. The fanlike shape and the absence of clay on the surface of the last outwash indicate that the water body in which the clay was laid down was partly or wholly drained during or before the deposition of the fan. The fan, however, is a part of the glacial sequence, for the hole now occupied by Spy Pond was then occupied by an ice block.

With the cessation of glacial deposition, late-glacial streams eroded the valleys in which the present streams flow. Apparently at the time of this erosion, ice blocks occupied the Mystic Lakes depressions; otherwise these basins would have been filled with sand and gravel. Since the last of the glacial-ice masses in the Fresh Pond area melted, some clay, silt, sand, gravel, and peat have been deposited in the streams, ponds, and marshes.

The relations of the various glacial deposits give a clue to the movement of ground water. Clay and clayey till are too impermeable to permit much movement of ground water; there is little flow, therefore, from the clayey areas into Fresh Pond. The sand and gravel on the NW. side of Fresh Pond seem to provide the pond with the greatest amount of ground water. If there is any important southward movement of ground water within 60 ft. of the surface along the buried valley to Fresh Pond, it is probably through thick peat deposits and associated sands.--Auth.

2-1119. Reilly, P.T. AERIAL DISCOVERIES IN THE GRAND CANYON: Plateau, v. 32, no. 3, p. 68-72, 3 illus., Jan. 1960.

The discovery of 4 natural bridges in Grand Canyon National Park through aerial reconnaissance is reported. All occur in the Redwall limestone (Mississippian). The name Keyhole Bridge is proposed for one in the Sinyala fault zone 1 mi. SW. of the junction of the fault tributary with 140 Mile Canyon. It was formed by cave-roof collapse, accelerated by the presence of a perennial spring above the point of roof collapse.--M. Russell.

2-1120. Miller, Don J. GIANT WAVES IN LITUYA BAY, ALASKA: U.S. Geol. Survey, Prof. Paper 354 C, p. 51-86, 15 illus., 8 maps (1 in pocket, scale 1:50,000), table, 1960, 75 refs.

Lituya Bay, on the NE. shore of the Gulf of Alask is an ice-scoured tidal inlet with a maximum depth of 720 ft. and a sill depth, at the narrow entrance, of only 33 ft. The northeastward-trending stem of

T-shaped bay, 7 mi. long and as much as 2 mi.
e, transects the narrow coastal lowland and foot-
s belt flanking the Fairweather Range of the St.
as Mountains. The 2 arms at the head of the bay,
bert and Crillon inlets, are part of a great trench
ng the Fairweather fault. Gentle slopes border
outer part of the bay, but the walls of the inner,
dlike part rise steeply to altitudes of 2,200 ft. to
re than 6,000 ft.

Until recently, little notice was taken of the giant
ves that have rushed out from the head of Lituya
, leaving sharp trimlines to mark the upper limit
otal or near total destruction of the forest along
shores. The dates of occurrence of 4 known and
nferred giant waves, and the maximum altitudes
heir trimlines are as follows: July 9, 1958 - 1,720
Oct. 27, 1936 - 490 ft.; 1899(?) - about 200 ft.;
ut 1874 - 80 ft.; and 1853 or 1854 - 395 ft.

In 1958 about 40 million cu. yds. of rock, loosened
her by displacement on the Fairweather fault or by
accompanying shaking, plunged into Gilbert Inlet
m a maximum altitude of about 3,000 ft. on the
ep NE. wall. This rockslide caused water to
rge over the opposite wall of the inlet to a maxi-
m altitude of 1,740 ft., and generated a gravity
ve that moved out the bay to the mouth at a speed
bably between 97 and 130 m.p.h. Two of 3 fish-
boats in the outer part of the bay were sunk, and
ersons were killed. The interpretation that water
s primarily responsible for destruction of the
est over a total area of 4 sq. mi. extending to a
ximum altitude of 1,720 ft. and as much as 3,600
in from the high-tide shoreline, is supported by
witness accounts of the survivors, by the writer's
d investigation, and by R. L. Wiegel's study of a
del of Lituya Bay and his calculations from exist-
theory and data on wave hydraulics.

The giant waves in 1936 were generated in Crillon
et. They were described by eyewitnesses at a
nt about midway along the bay as 3 waves of in-
easing height, in close succession and traveling
ut 22 m.p.h. Of the possible causes considered
e, movement of a tidal glacier front or submarine
ding seems most likely but can be neither dis-
oved nor conclusively supported from the informa-
n at hand.

The configuration of trimlines formed by giant waves in late 1853 or early 1854 (dated by tree ring count) and about 1874, suggests sliding from the S. wall of Lituya Bay at Mudslide Creek as a likely cause. A slide, fault displacement, or some other disturbance in Crillon Inlet may have caused another giant wave during one of the great earthquakes in Sept. 1899.

The frequent occurrence of giant waves in Lituya Bay, as compared to other similar bays, is attributed to the combined effect of recently glaciated steep slopes, highly fractured rocks and deep water in an active fault zone, heavy rainfall, and frequent freezing and thawing. These waves are likely to occur again, and should be taken into account in any future use of Lituya Bay. Other giant waves have been caused by sliding of part of a mountain into Shimabara Bay in Japan; repeatedly by falling or sliding of rock masses into Loen Lake, Tafjord, and Langfjord in Norway; by avalanching of a hanging glacier into Disenchantment Bay in Alaska; and repeatedly by landslides into Franklin D. Roosevelt Lake in Washington.--Auth.

2-1121. Rosalsky, Maurice B. THE PHYSIOGRAPHY OF CAPE CANAVERAL, FLORIDA: Rocks & Minerals, v. 35. no. 3/4, p. 99-102, 3 maps, March-Apr. 1960, 8 refs.

Cape Canaveral is a cuspate foreland developed upon the narrow barrier beach which extends for many miles along the E. coast of Florida. It is suggested that the foreland developed at its present position because of conflicting coastal currents which caused eddies and sand deposition. The stages of development are reviewed from early prograding shoreline to the present. Concepts of previous writers are cited and compared. Evidence is cited to show that the earliest foreland developed approximately 7 mi. somewhat W. of N. of present Cape Canaveral. Changes in coastal configuration from stage to stage are indicative of changes in ocean currents along this area of the Florida coast.--J. Sinkankas.

3. STRUCTURAL GEOLOGY

e also: Areal and Regional Geology 2-1057, 2-1089;
omorphology 2-1117; Geophysics 2-1164, 2-1170,
1187, 2-1193, 2-1194, 2-1195; Fuels 2-1293.

**1122. Rod, Emile. STRIKE-SLIP FAULT OF
NTINENTAL IMPORTANCE IN BOLIVIA: Am.
ssoc. Petroleum Geologists, Bull., v. 44, no. 1,
107-108, 2 maps, Jan. 1960.**

Field work and literature study has led to the
llowing working hypothesis: the northern half of
uth America has been displaced relative to its
uthern half, toward the W. along a fault zone
lled here the Ichilo fault. Evidence is based on
few scattered observations, and the details will
presented later.--I. M. Johnston.

**1123. Thompson, R. Bruce, Jr. SOME OBSER-
ATIONS ON STRUCTURE AND METAMORPHISM
THE HARRISBURG, N.Y., QUADRANGLE: New
rk Acad. Sci., Trans., v. 22, no. 3, p. 191-195,
n. 1960.**

The Harrisburg quadrangle is in the southeastern Adirondack Mountains, near the border of the massif, but entirely within the Precambrian complex of the mountains. All the rocks of the quadrangle have been metamorphosed. The predominant rocks in the area are Grenville gneisses and rocks derived from them during metamorphism. The major intrusive rocks are hornblende granite and anorthosite, and there is a minor amount of gabbro. Brief descriptions of the following major rock units are included: Grenville gneiss, "meta-Grenville" gneiss, porphyroblastic gneiss, Alaskitic gneiss, hybrid gneiss, hornblende granite gneiss, anorthosite, and gabbro.

Tentative interpretation of the geologic history of the quadrangle suggests the following sequence:

1) Emplacement of anorthosite and gabbro intrusives into pre-existing Grenville gneiss, followed or accompanied by deformation and by granitization of the Grenville rocks.

2) Later intrusion and deformation of hornblende granite, which combined in some places with Grenville rocks to form a hybrid gneiss.

3) Faulting, possibly reactivated at successive

intervals.

4) A long-continued erosion, continuing through much of the later history of the quadrangle and giving rise to land forms modified by fault and joint lines and by structure and variable resistance of the bedrock.--From auth. introd. & concl.

2-1124. Olenin, V.B., and B.A. Sokolov. TECTONIC STRUCTURE AND OIL AND GAS POTENTIAL OF THE KOLKHIDA PLAIN AND ADJACENT REGIONS. Translated by Research International Associates: Internat. Geology Rev., v. 2, no. 2, p. 93-102, 4 maps, 3 secs., Feb. 1960, 18 refs.

Western Georgia is in the eastern part of the Riono-Black Sea intermontane oil and gas reservoir. Coastal Abkhaziya and the Colchis plain are favorable for oil and gas prospecting as Mesozoic sediments are here overlain by a series of Tertiary and Quaternary rocks. From the Recent tectonic pattern, evolution, age, and composition of the present complexes the authors could outline 3 tectonic regions: Guri, Colchis, and Abkhazsko-Megrel.

The geological pattern of the Colchis region has recently become better known. Borehole data indicate the presence of a heavy Cretaceous carbonate series (over 1,000 m. thick) overlain with sharp angular unconformity by Pliocene and Quaternary argilloarenaceous sediments.

From data obtained by seismic prospecting, drillhole exploration, and geological survey, the conclusion [was reached] that all brachyanticlines in the Colchis region might be grouped into 3 anticlinal zones, namely northern Colchis, central Colchis, and southern Colchis. Within the northern Colchis zone 3 brachyanticlines (Ingur, Ochemchiri, and Kodor) are distinguished. The same confinement o separate uplifts to the anticlinal zones may be observed in the Abkhazsko-Megrel and Guri region where an over-all complex of Tertiary sediments i developed. In the area under discussion 2 structur layers are isolated: the lower Domeotic and the upper, consisting of Pliocene-Quaternary rocks. T lower layer is characterized by intermittent folding the upper one by nearly horizontal bedding. The oi content of the Cretaceous sediments in western Georgia is known from drilling data and abundant o and gas occurrences. In this connection certain Colchis brachyanticlines are of great interest for oil and gas prospecting within the Cretaceous carbonate complex.--Auth.

2-1125. Rudkevich, M. Ya. TECTONIC STRUCTURE OF THE WESTERN BLACK SEA REGION. Translated by Research International Associates: Internat. Geology Rev., v. 2, no. 2, p. 107-113, 2 maps, Feb. 1960, 18 refs.

The geologic structure and history of structural development in the western part of the pre-Black Se depression during the Paleozoic and Mesozoic are discussed. The author concludes that the so-called "pre-Black Sea depression" is not an area of prolonged downwarping. Thus, the term "pre-Black Se depression" should be replaced by "pre-Black Sea block."--Auth.

4. STRATIGRAPHY AND HISTORICAL GEOLOGY

See also: Geologic Maps 2-1040, 2-1044; Areal and Regional Geology 2-1056, 2-1058 through 2-1061, 2-1063, 2-1064, 2-1096 through 2-1104; Paleontology 2-1156, 2-1162; Geophysics 2-1168; Mineral Deposits 2-1262, 2-1270; Fuels 2-1295.

2-1126. Young, Keith. BIOSTRATIGRAPHY AND THE NEW PALEONTOLOGY: Jour. Paleontology, v. 34, no. 2, p. 347-358, March 1960, 50 refs.

The increasing acceptance of the concept of a species varying in time, comparable to the geographic variation of species, alters the entire nomenclatural basis of biostratigraphy. Biostratigraphers must reorient their basic concepts to those of correlating samples from supplies that represent some unknown segments of the biological continuum. Biostratigraphers cannot continue to use taxa (species) of the "New Paleontology" for smaller biostratigraphical units because they are not sufficiently refined to meet the need for detail in modern and future stratigraphy.--Auth.

2-1127. Hansen, Wallace R. IMPROVED JACOB STAFF FOR MEASURING INCLINED STRATIGRAPHIC INTERVALS: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 2, p. 252-254, illus., diag., Feb. 1960, 2 refs.

Details of an improved Jacob staff are put into the literature as a reference for all field geologists. The new Jacob staff is built around a standard Abney-level head with an auxiliary clinometer and spirit level and has the following chief advantages over other Jacob staffs: 1) it is useful in traversing along as well as across strike, and 2) the length of the staff is adjustable. The various components are detachable. Th procedure for measuring sections across strike either up or down dip is quite simple. It is hoped geologists will find this new field aid of use in field mapping.--I. M. Johnston.

2-1128. Barnes, Virgil E., and others. STRATIGRAPHY OF THE PRE-SIMPSON PALEOZOIC SUB SURFACE ROCKS OF TEXAS AND SOUTHEAST NE MEXICO: Texas, Univ., Pub. 5924, 3 v. (2 v. text 1 v. pls.), 38 figs., 65 pls., 14 tables, Dec. 1959, 141 refs.

This publication is the result of a 5-year projec the scope of which is indicated by the title. Variou techniques and methods were investigated to find th simplest way to recognize subdivisions of these ro from place to place. The research was performed the author, with the aid of other scientists in speci ized fields.--V. E. Barnes.

The papers are contained in v. 1; v. 2 contains supplementary data in 11 appendices. The appendices cover: A. Data on Pre-Simpson Wells Arranged by Companies; B. Description of Cores, Core Sections, Core Chips, and Cuttings from Individual Wells; C. Resume of Anhydrite Distribution; D. Outline of Structure and Solution Phenomena; E. Samples Prepared for Insoluble Fossil Examinatio F. Description of Thin Sections From Selected We G. Spectrochemical Analyses of Pre-Simpson and Younger Rocks; H. Chemical Analyses of Cores Fr Phillips Petroleum Company No. 1 Wilson, Val Ve County; I. Analyses for Phosphorous Pentoxide in Cambrian and Ordovician Rocks, Surface Sections, Eastern Part of Llano Region, Texas; J. Peak-heigh Ratios of Glow Curves for Pre-Simpson and other eozoic Rocks From Wells and Surface Sections, utheast New Mexico and Texas; K. Insoluble Resi- e Data for Individual Wells.

Each paper is abstracted separately below in the der in which it appears in the publication.

1129. Barnes, Virgil E. STRATIGRAPHY OF E PRE-SIMPSON PALEOZOIC SUBSURFACE CKS OF TEXAS AND SOUTHEAST NEW MEXICO : Barnes, Virgil E., and others. Stratigraphy of Pre-Simpson Paleozoic Subsurface Rocks of Tex- and Southeast New Mexico: Texas, Univ., Pub. 24, v. 1, p. 11-72, 200-231, v. 2, p. 295-720, 2-819, 22 pls. incl. pls. under separate cover, 6 aps, diag., log., 3 tables, Dec. 1959) 33 refs.

Ellenburger, Wilberns, and Riley rocks of Lower dovician and Upper Cambrian age were examined various ways to determine the manner in which ese rocks could be subdivided into recognizable its in the subsurface and the various units be re- gnized from place to place. Techniques and meth- s tried, listed in approximate order of decreasing efulness (nil in the last 5 categories), include: 1) bin- ular-microscope examination of untreated samples, study of fossils, 3) thin section examination, 4) dioactivity and electrical logging for Riley and Wil- rns rocks alone, 5) binocular-microscope exami- tion of insoluble residues, 6) spectrochemical and nventional chemical analyses, 7) thermolumines- nce, 8) X-ray examination of clay-size minerals, magnetic susceptibility, and 10) search for fossils soluble in hydrofluoric acid.

Criteria of most value for subdividing these rocks e grain size, distribution and kind of chert and her insoluble materials, distribution of color, and e presence of sandstone units and glauconite in the ilberns and Riley formations. Subdivisions of lenburger rocks found in the subsurface closely rrespond to the Tanyard, Gorman, and Honeycut rmations of central Texas and the B2a, B2b, and units of Trans-Pecos Texas previously established Cloud and Barnes.

Dominance of dolomite and the presence of anhy- ite and zones of varvelike bedding in W. Texas dicate hypersaline water and some primary pre- pitation of dolomite during part of Ellenburger time.

Pre-Simpson rocks were disturbed by soft sedi- ent deformation, solution and collapse related to conformities, and Pennsylvanian tectonic deforma- on. Most of the fracture porosity responsible for l and gas production may have formed at that time. Auth.

-1130. Cloud, Preston E., Jr., and Allison R. almer. PALEONTOLOGIC DATA AND AGE EVAL- ATION FOR INDIVIDUAL WELLS, PRE-SIMPSON ALEOZOIC ROCKS (*In*: Barnes, Virgil E., and hers. Stratigraphy of the Pre-Simpson Paleozoic ubsurface Rocks of Texas and Southeast New Mex- o: Texas, Univ., Pub. 5924, v. 1, p. 73-85, 232- 35, 2 pls., map, Dec. 1959) 9 refs.

Fossils were examined from 64 Texas and New exico wells for purpose of dating and stratigraphic orrelation of Upper Cambrian and Lower Ordovician ocks. Genera of value for correlation and dating clude: *Apsotreta*, *Huenella*, *Polytoechia*, *Pomato- ema*, *Diparelasma*, *Hormotoma*, *Euconia*, *Orospira*, *rchaeoscyphia*, *Kinsabia*, *Labiostria*, and the sau- id trilobites. These and a few other forms are lustrated and briefly described.--Auth.

2-1131. Tynan, Eugene J. EXAMINATION OF PRE-SIMPSON PALEOZOIC ROCKS FOR INSOLUBLE FOSSILS (*In*: Barnes, Virgil E., and others. Stratigraphy of the Pre-Simpson Paleozoic Subsurface Rocks of Texas and Southeast New Mexico: Texas, Univ., Pub. 5924, v. 1, p. 87-93, v. 2, p. 721-726, map, Dec. 1959) 19 refs.

Four hundred sixty-one samples from 21 localities, both surface and subsurface, were examined for insoluble fossil content. The samples were mostly from the Lower Ordovician, some from the Upper Cambrian, and a few from immediately overlying rocks of the Middle Ordovician Simpson group. All of the samples are essentially barren of insoluble fossils.--Auth.

2-1132. Folk, Robert L. THIN-SECTION EXAMINATION OF PRE-SIMPSON PALEOZOIC ROCKS (*In*: Barnes, Virgil E., and others. Stratigraphy of the Pre-Simpson Paleozoic Subsurface Rocks of Texas and New Mexico: Texas, Univ., Pub. 5924, v. 1, p. 95-130, 236-291, v. 2, p. 727-801, 28 pls., 2 maps, 5 diags., 3 tables, Dec. 1959) 13 refs.

The Ellenburger group in the area studied consists largely of dolomite, with limestone present in the eastern part. There is very little terrigenous material; this consists of a trimodal mixture of well-rounded medium sand, coarse silt, and clay. Throughout most of the area, sands are supermature orthoquartzites, but in certain horizons in W. Texas and New Mexico immature arkoses are present. This indicates that the source for the sand was probably a warm and humid linear granitic upland between Lea County, New Mexico, and Pecos County, Texas. The high degree of rounding of the supermature sands was all accomplished during Ellenburger deposition.

The Ellenburger carbonates contain abundant intraclasts (grains of reworked semiconsolidated lime sediment), oōlites, fecal(?) pellets, and few fossils. A very large amount of microcrystalline calcite is present as an original matrix between the transported carbonates and also forms a rock in its own right. Sparry calcite (clear) was formed as a pore-filling cement in those sediments which consisted of relatively winnowed carbonate sands; there appears to be little or no recrystallization of calcite in the Ellenburger limestones. Nearly all the dolomite in the Ellenburger has formed by replacement of limestone, probably shortly after deposition. All the chert nodules are of replacement origin, but replacement occurred shortly after deposition while the lime sediment was still soft. It is found that chert can replace both limestone and dolomite, dolomite can replace both limestone and chert, and calcite can (rarely) replace both chert and dolomite.

A new classification of limestones is introduced and discussed at some length. Limestones are divided into 3 basic families depending on the proportion of 1) allochems - transported carbonate grains, analogous to the sand grains of a sandstone; 2) microcrystalline ooze, analogous to the clay matrix of a sandstone; and 3) sparry calcite cement, analogous to the pore-filling cement that occurs in well-winnowed sandstones. These families are subdivided depending on the dominant allochem (intraclasts, oōlites, fossils, or pellets). The rock name is then compounded of these 2 elements, for example, intrasparite or biomicrite. The Ellenburger is largely intrasparite, pelsparite, and micrite.

The Ellenburger sediments are believed to have formed in a calm, shallow warm sea that was more saline to the W., resulting in the formation of dolomite and some evaporites in that area, while limestone formed farther to the E. as a result of influx of fresher water from a postulated series of welts that lay far SE. of the area of study.--Auth.

2-1133. Jonas, Edward C. **CLAY-SIZE MINERALS IN ELLENBURGER ROCKS (In: Barnes, Virgil E., and others. Stratigraphy of the Pre-Simpson Paleozoic Subsurface Rocks of Texas and Southeast New Mexico: Texas, Univ., Pub. 5924, v. 1, p. 131-143, 292-293, pl., map, diag., 2 tables, Dec. 1959) 4 refs.**

The clay-size fraction from the insoluble residue of Ellenburger cores was studied by X-ray diffraction. Carbonate was dissolved by batch reaction of the rock with H resin to minimize the damage generally done to clay minerals by strong acids. The typical suite of clay minerals includes mica, chlorite, and an interlayer mixture of illite and montmorillonite. The rocks are characterized by varying proportions of montmorillonite in the interlayer mixture, the degree of crystallinity of chlorite, and the polymorphic form of mica.

The clay-mineral composition of Ellenburger rocks suggests that the source of this detrital material was an igneous rock subjected to mild chemical weathering and moderately rapid erosion.--Auth.

2-1134. Barnes, Virgil E. **CHEMICAL EXAMINATION OF PRE-SIMPSON PALEOZOIC ROCKS (In: Barnes, Virgil E., and others. Stratigraphy of the Pre-Simpson Paleozoic Subsurface Rocks of Texas and Southeast New Mexico: Texas, Univ., Pub. 5924, v. 1, p. 145-163, v. 2, p. 802-811, 4 pls. under separate cover, map, 2 diags., 5 tables, Dec. 1959) 21 refs.**

Ellenburger, Wilberns, and Riley rocks of Lower Ordovician and Upper Cambrian age were examined by spectrochemical and ordinary chemical analytical methods. These methods do not provide a sound basis for subdivision where these rocks are dolomite.

The results for limestone are more promising, but only in the eastern area does limestone make up a substantial part of the sequence. In the southeastern area minor and trace elements are mostly erratically distributed in the upper two-thirds of the Honeycut formation. The lower third of the Honeycut, all the Gorman, and the upper half of the Tanyard are poor in most constituents and are of rather uniform composition. Below the middle of the Tanyard formation most constituents, except magnesia, cupric oxide, and strontium oxide, are more abundant and somewhat erratically distributed. The lower part of the San Saba member, Morgan Creek limestone, and the limestone in the Lion Mountain sandstone are especially rich in Fe and soda. The Cap Mountain limestone, except for a high manganous monoxide and strontium oxide content, resembles more nearly the Ellenburger than it does the rest of pre-Ellenburger rocks. Phosphorous pentoxide is distinctly more abundant in most Cambrian rocks than in Ordovician rocks.

To the NE. only the upper part of the sequence was tested, and nothing was found that might be of value for subdivision except chromic sesquioxide in the upper part of the West Spring Creek formation. Two Rb-Sr ages quoted for the glauconitic Lion Mountain sandstone are 392±(30) and 436±(20) million years.--Auth.

2-1135. Barnes, Virgil E. **THERMOLUMINESCENCE OF PRE-SIMPSON PALEOZOIC ROCKS (I Barnes, Virgil E., and others. Stratigraphy of th Pre-Simpson Paleozoic Subsurface Rocks of Texas and Southeast New Mexico: Texas, Univ., Pub. 59 v. 1, p. 165-183, v. 2, p. 812-819, 6 pls. under separate cover, 10 figs. incl. map, 3 diags., Dec 1959) 26 refs.**

Ellenburger, Wilberns, and Riley rocks of Low Ordovician and Upper Cambrian age were examine for their thermoluminescence properties. For su dividing these rocks, thermoluminescence is of litt value except that Ellenburger rocks can be distinguished (and this not too consistently) from older rocks. Limestone and dolomite are easily distinguished by this method, but use of acid is simpler and less costly.

The glow curves for limestone and dolomite are different; therefore, each must be considered sepa rately in a laterally gradational sequence of limestone and dolomite. The low temperature peak fo irradiated limestone is mostly more intense for Ordovician limestone than for Cambrian limestone. The reason for this is unknown, but factors, some of which may be responsible, are: greater pressur on Cambrian rocks, more dolomite in them, highe insoluble residue, and darker color. Grain size is not responsible. Peak-height ratios for limestone are erratic except that the medium- to low-temperature peak-height ratio mostly increases slightly downward.

For dolomite there is no apparent consistency i glow curve intensity either for age or grain size except that the low-temperature peak is mostly mo intense than the high-temperature peak for the younger and finer grained dolomites, and the rever is true for the older and coarser grained dolomites The peak-height ratios for dolomite are even more erratic than those for limestone; however, detecta variations include: 1) increase downward of high- t low-temperature peak-height ratio, 2) increase do ward, except in 1 well, of medium- to low-temperature peak-height ratio, 3) decrease downward of medium- to high-temperature peak-height ratio. These variations are not related to dolomite grain size.--Auth

2-1136. Barnes, Virgil E. **USE OF COLOR FOR CORRELATING PRE-SIMPSON PALEOZOIC ROCK (In: Barnes, Virgil E., and others. Stratigraphy o the Pre-Simpson Paleozoic Subsurface Rocks of Te and Southeast New Mexico: Texas, Univ., Pub. 59 v. 1, p. 185-189, 294, pl., map, table, Dec. 1959 ref.**

The pre-Simpson sequence of Paleozoic rocks h a sufficient color range so that recording color fu nishes contributory evidence for the identification various units. These rocks as a whole darken tow the Val Verde, Delaware, and Anadarko basins an also somewhat toward the Collin County area of N Texas.

In the Ellenburger sequence in the western area unit B2b' is darker colored than either overlying u C' or underlying unit B2a', except that eastward, u B2a' darkens to almost the color of unit B2b'. The upper part of the Honeycut formation is darker tha unit B2a', and downward the Honeycut is lighter co ored. The Gorman formation to the W. is somewh darker than the lower part of the Honeycut; to the the 2 are about the same. In the W. the Gorman i about the same color as the underlying Tanyard mation. Eastward the upper part of the Tanyard ighter colored than the Gorman, the middle part ut the same as the Gorman, and the lower part readgill member) much lighter than the Gorman. cept in the eastern part of the Llano region the Saba member is darker than the Threadgill; here in the subsurface to the W. the 2 are of about the ne color.

The pink zone at the base of the Morgan Creek estone member is characteristic of its outcrop a and the immediate subsurface, as is also the k green greensand of the Lion Mountain sandstone mber. The red zone at the top of the Hickory dstone member passes laterally into the Cap untain limestone member southeastward within Llano region. Other less pronounced color dif- ences are recorded in Wilberns and Riley rocks.-- th.

137. Barnes, Virgil E., and Lane P. Dixon. OLUBLE RESIDUES OF ELLENBURGER SUBSUR- CE ROCKS (In: Barnes, Virgil E., and others. atigraphy of the Pre-Simpson Paleozoic Subsur- e Rocks of Texas and Southeast New Mexico: Tex- Univ., Pub. 5924, v. 1, p. 191-198, v. 2, p. 1-836, pl. under separate cover, map, diag., Dec. 69) 15 refs.

Insoluble residues were examined from rocks of Ellenburger group in Texas and SE. New Mexico the results compared with correlations made m all available criteria. It was found that cor- lations made with acid-insoluble residues alone, ile of some value, are not nearly as reliable as rrelations made by using all available evidence, ich of course includes observation of the insoluble terials as they are found in the rock.--V. E. Barnes.

1138. Semikhatova, S.V. STAGES IN THE DE- LOPMENT OF BRACHIOPODS AS ONE OF THE ITERIA FOR ESTABLISHING STRATIGRAPHIC UNDARIES IN THE CARBONIFEROUS. Trans- ed by Research International Associates: Internat. ology Rev., v. 2, no. 2, p. 144-155, 5 tables, b. 1960, 48 refs.

The basic stages in the development of brachio- ds corresponding to the boundaries of divisions d stages of the Carboniferous are briefly examined. ta on the stratigraphic and geographic distribution the more characteristic genera and species are alyzed. The author concludes that in the brachio- d fauna of the Carboniferous, which form a single, tually related whole, 2 main boundaries occur. is necessitates a 3-fold division of the Carbonifer- s.--Auth.

1139. Harbaugh, John W. MARINE BANK DE- LOPMENT IN PLATTSBURG LIMESTONE (PEN- YLVANIAN), NEODESHA-FREDONIA AREA, KAN- S: Kansas, State Geol. Survey, Bull. 134, pt. 8, 289-331, 24 illus. on 10 pls., 3 maps (2 in pock- , 8 secs. (1 in pocket), diag. in pocket, table, 59, 19 refs.

The Plattsburg limestone is anomalously thick in e Neodesha-Fredonia area, increasing from an erage of about 20 ft. to a maximum thickness of 5 ft. Thickening is due to increase in the Hickory eek shale (middle member) from 1 to 45 ft., and e Spring Hill limestone (upper member) from 3 to ft. in thickness.

The Plattsburg limestone and the overlying Vilas shale have been studied in outcrops in the eastern part of the Neodesha-Fredonia area and have been traced underground in the central and western parts of the area by means of about 200 drillers logs. Nineteen outcrop sections, measured, described, and sampled in detail, form the basis for lithologic and genetic interpretations. About 150 rock samples were studied microscopically by means of acetate peels and enlarged negative photographic prints made from the peels.

The principal cause of thickening of Plattsburg limestone is interpreted to be deposition of an extensive, lens-shaped marine bank that rose above the general level of the surrounding sea floor. The bank was at least 14 mi. long in a NW.-SE. direction, and about 10 mi. wide. Two smaller, detached thickened portions of the Plattsburg limestone in the area probably represent small banks. A second cause of thickness variations in the Plattsburg limestone is local structural warping during deposition, which permitted greater thicknesses to accumulate over downwarps and lesser thicknesses over upwarps. Thickness of the Vilas shale also has been affected by this cause.

Thickness of the Vilas shale has been observed to be inversely related to thickness of the Plattsburg limestone at most localities. Part of the Vilas shale is interpreted to be an off-bank time equivalent of part of the thickened Spring Hill member.

Deposition of the bank is interpreted to have been strongly influenced by lime-secreting organisms, including crinoids, bryozoans, brachiopods, mollusks, and algae. The organisms may have influenced deposition of silt and clay (Hickory Creek member) by exerting a sediment-binding effect, and probably helped stabilize slopes at least as great as 7° on the edges of the bank. In addition, they contributed large quantities of calcareous material to the upper part (Spring Hill member) of the bank.

Where thick, the Spring Hill member of the Plattsburg is divided into 3 tabular lithologic subdivisions in regular vertical sequence. The lower subdivision contains abundant irregular fragments and pellets, much of it seemingly of algal origin. The middle subdivision contains abundant visibly crystalline calcite intimately associated with encrusting calcareous algae. The upper subdivision contains abundant calcarenite composed of grains of various degrees of rounding and sorting. During deposition of the crystalline subdivision, lime-secreting algae may have imparted rigidity to deposits forming on the bank, thus creating a reef if the bank extended into shallow water. During deposition of other parts of the Plattsburg bank, the deposits probably were not wave resistant.

Porosity in the Spring Hill member is related to limestone lithology. The crystalline limestone subdivision, where pores and vugs are conspicuous in visibly crystalline calcite, is most porous. The thickened Spring Hill limestone of the Neodesha-Fredonia area may provide an example of a porous limestone lens that might serve as an oil reservoir; some oil pools in Pennsylvanian limestones of central and western Kansas may occur in porous lenses of similar origin.--Auth.

2-1140. Brown, L. F., Jr. STRATIGRAPHY OF THE BLACH RANCH-CRYSTAL FALLS SECTION (UPPER PENNSYLVANIAN), NORTHERN STEPHENS COUNTY, TEXAS: Texas, Univ., Bur. Econ. Geology, Rept. Inv. no. 41, 45 p., 6 figs., 3 pls. (incl. col. geol. map), Apr. 1960, 18 refs.

Three mappable members in the upper part of the Thrifty formation (Blach Ranch limestone, unnamed shale, and Breckenridge limestone), 2 in the lower part of the overlying Harpersville formation (Quinn clay and Crystal Falls limestone), and 6 minor lentils, all in the outcropping Cisco group, northern Stephens County, Texas, have been mapped and are described. The Blach Ranch, Breckenridge, and Crystal Falls limestone members, which are important regional stratigraphic markers in surface Cisco rocks of the Brazos Valley, have been redescribed at type localities in the area.

Plummer and Moore's original Thrifty and Harpersville formations are used, but future revision of the classification, based on additional detailed mapping in the Brazos Valley, is recommended. Cisco is recognized as a group (rock unit), that includes the Graham, Thrifty, and Harpersville formations, rather than as a series (time-rock unit).

The rocks (about 100 ft. thick) were deposited under cyclic, rapidly changing, shallow marine to nonmarine conditions. Thin fossiliferous persistent limestone beds mark maximum but shallow marine transgression; they are separated by clay and shale containing sandstone beds and channels that mark maximum regression for this section in the area. Each limestone member is cut by one or more channel sandstones that originated in the overlying clay and shale members. Minor local calcareous units, which are commonly fossiliferous, nearshore deposits, pinch out laterally and/or change composition abruptly.--Auth.

2-1141. Fisher, D. Jerome, Charles E. Erdmann, and John B. Reeside, Jr. CRETACEOUS AND TERTIARY FORMATIONS OF THE BOOK CLIFFS, CARBON, EMERY AND GRAND COUNTIES, UTAH, AND GARFIELD AND MESA COUNTIES, COLORADO: U.S. Geol. Survey, Prof. Paper 332, 80 p., 25 illus., 2 maps (1 in pocket), 2 secs. (in pocket), diag. (in pocket), 20 tables, 1960, 91 refs.

The Book Cliffs form a sinuous southward-facing escarpment that extends in a general eastward direction from the Wasatch plateau in central Utah to Grand Mesa in western Colorado - a distance of 150 mi. The part of the Book Cliffs from the Wasatch plateau to the Green River may be referred to as the western cliffs, the part in Utah E. of the Green River as the central cliffs, and the part in Colorado as the eastern cliffs. S. of the cliffs and bordering them continuously is a lowland locally bearing such names as Castle Valley and Grand Valley. S. of the lowland lie 3 major structural features: from W. to E. the San Rafael swell, the Salt Valley anticline, and the Uncompahgre uplift, which cause the sinuosity of the trend of the cliffs. At distances ranging up to 10 mi. N. of the Book Cliffs is another escarpment, the Roan or Brown Cliffs.

The lowland, the Book Cliffs, and the Roan Cliffs consist of Cretaceous and Tertiary strata that dip gently northward into the Uinta basin and reach a total thickness of about 7,000 ft. The age range of the strata is from Early Cretaceous to Eocene.

The Cretaceous rocks include, at the base Lower Cretaceous units, the Cedar Mountain formation in Utah and the Burro Canyon formation in Colorado; then, in ascending order, Upper Cretaceous units, the Dakota sandstone, the Mancos shale, and the Mesaverde group. Above the Mesaverde group in the Book Cliffs are formations of undetermined age that seem to include beds which are also found in the Wasatch plateau, where they extend from the Cretaceous into Tertiary; therefore, these formations a here called Cretaceous and Tertiary also. Above them are units considered definitely Tertiary. Th Mesaverde group, because of lateral changes in ch acter and composition, is divided into 3 sets of uni In the western cliffs the Star Point formation is not present as such, and the Blackhawk formation at th base of the group is overlain by the Castlegate san stone and the Price River formation (restricted by removal of the Castlegate). In the central cliffs th much-thinned Blackhawk formation is overlain in succession by the Castlegate sandstone, the Buck tongue of Mancos shale, the Sego sandstone, the Nelson formation, the Farrer formation, and the Tuscher formation. In early reports the Sego, Nes len, and the Farrer formations have been consider members of the Price River formation, and the Tus cher formation was not included in the Mesaverde group. In the eastern cliffs the Sego sandstone is the basal unit, containing the Anchor Mine tongue of Mancos shale; the Sego is overlain by the Mount Garfield formation, containing in the lower part the "coal measures" with the Rollins sandstone membe and in the upper part the "barren measures"; at the top is placed the Hunter Canyon formation. The formations assigned to the Cretaceous and Tertiary are the North Horn and Flagstaff formations, undifferentiated, in the western cliffs and the western part of the central cliffs. The Tertiary formations are an unnamed sandstone in the eastern cliffs, the Colton formation of Eocene age in the western cliffs the "Wasatch" formation of possible Paleocene and Eocene age in the central and eastern cliffs, and th Green River formation of Eocene age.

A comparison with standard sequence for the Rocky Mountains region indicates that the Lower Cretaceous formations are equivalent in age to the Kootenai formation (Aptian), the Dakota sandstone i early Late Cretaceous (Cenomanian), the Mancos shale includes rocks ranging in age from equivalent of the lower parts of the Bridge Creek limestone me ber of the Greenhorn limestone (late Cenomanian o early Turonian) to equivalents in the W. perhaps of the Sharon Springs member of the Pierre shale and to equivalents in the E. of the Gregory member of the Pierre shale (Campanian). The Mesaverde grou generally has not yielded faunas datable more close than very late Cretaceous.

The Lower Cretaceous rocks are nonmarine and fluviatile. The Dakota is both marine and nonmari in Colorado and nonmarine and discontinuous in Uta The Mancos shale is of marine origin, and the lowe parts of the Mesaverde are marine and brackish water, but the upper parts are everywhere nonmari The Upper Cretaceous beds record the entry into th region from the S. and E. of marine waters that spread rapidly; in these formed an initial deposit of sandy materials (Dakota). Then, over a long perio the finer materials now composing the main body of the Mancos shale were deposited in the marine wate These materials, though dominantly fine grained, were variable in character; notable hiatuses may be present. Deposition of the coarser grained Mesaverde group began much earlier in the W. than the E. and proceeded with much oscillation of the shore line, recorded by the temporary extension of sandy marine sedimentary rocks and nonmarine rocks eas ward and intervening extension of marine finer sedimentary rocks westward, though the net movement was a steady eastward retreat of the sea. The uppe most parts of the Mesaverde group are all nonmari rocks. The post-Mesaverde rocks are terrestrial.- Auth.

1142. Sanderson, Milton W., and Thomas H.
arr. AMBER WITH INSECT AND PLANT INCLU-
ONS FROM THE DOMINICAN REPUBLIC: Science,
131, no. 3409, p. 1313, Apr. 29, 1960, 23 refs.

An amber-bearing formation [Oligocene?] observed
the Dominican Republic in 1959 is described, and
everal insect orders, spiders, and plants found in
mber are noted. An amber trace is recorded for
aiti, and the known fossil-bearing amber deposits
sites in the New World are summarized.--Auth.

1143. Smith, Patsy Beckstead. FORAMINIFERA
F THE MONTEREY SHALE AND PUENTE FORMA-
ON, SANTA ANA MOUNTAINS AND SAN JUAN
APISTRANO AREA, CALIFORNIA: U.S. Geol. Sur-
y, Prof. Paper 294-M, p. 463-495, 2 maps, sec.,
tables, 1960, 16 refs.

In the Santa Ana Mountains and San Juan Capistrano
rea, Orange County, thick sections of Miocene sedi-
entary rocks are exposed. They are assigned to
e Monterey shale of middle and late Miocene age
nd the Puente formation of late Miocene age. The
rea described is divided into 4 geographic units; the
rthern and central Santa Ana Mountains, the south-
stern Santa Ana Mountains, the area E. of Oso
eek (E. flank of the Capistrano syncline), and the
ea W. of Oso Creek (W. flank of the Capistrano
ncline). The faunal assemblages of each area are
mpared with those of the California Miocene stages
oposed by Kleinpell.

In the Santa Ana Mountains, the Topanga formation
elizian(?) stage) and the El Modeno volcanics
uisian stage) are overlain unconformably by the
ente formation (Mohnian stage).

On the E. flank of the Capistrano syncline, S. of
e El Toro Air Station, the Topanga formation is
erlain by the Monterey shale, which ranges in age
from late Luisian at the base to Mohnian at the top.

To the W. of Oso Creek, the Topanga formation is overlain by the Monterey shale which ranges in age from early Luisian at the base to late Luisian and Mohnian at the top.

Changes in thicknesses of rocks assigned to the Luisian and Mohnian stages are due to unconformities and local depositional variations. No evidence was found to indicate that foraminiferal faunas assigned to the Mohnian stage grade laterally into faunas of the Luisian stage.--Auth.

2-1144. Hurley, Patrick M., H.W. Fairbairn, William H. Pinson, and G. Faure. K-A AND Rb-Sr MINIMUM AGES FOR THE PENNSYLVANIAN SECTION IN THE NARRAGANSETT BASIN: Geochim. et Cosmochim. Acta, v. 18, no. 3/4, p. 247-258, map, 7 tables, Feb. 1960, 20 refs.

K-A and Rb-Sr age measurements on metamorphic minerals in the Rhode Island and Wamsutta formations of Pennsylvanian (Allegheny) age in the Narragansett basin, Rhode Island, indicate that the minimum age of these formations is 255 million years. Intrusive granites cutting the Wamsutta formation show a minimum age of 235 million years. The fairly widespread orogenic event in the Appalachians that caused metamorphism and igneous rock emplacement showing ages in this range is therefore post lower Pennsylvanian, and should be referred to as Appalachian rather than Acadian. The concordant Pb ages in the pegmatites of Middletown, Connecticut, are of this age. As these were used as the basis of a Devonian age point in the present time scale of Holmes, it is clear that the scale must be lengthened. These results are in accordance with a new value of 360 million years for the minimum age of the lower Devonian, reported earlier.--Auth.

5. PALEONTOLOGY

e also: Areal and Regional Geology 2-1053; Stratig-
aphy 2-1126, 2-1130, 2-1131, 2-1138, 2-1142, 2-1143;
eochemistry 2-1221.

-1145. Easton, W.H. INVERTEBRATE PALEON-
OLOGY: 701 p., illus., diags., tables, New York,
arper & Brothers, 1960, refs.

This textbook is planned for a course in inverte-
rate paleontology offering as much as one year of
raining, but it should be adaptable to two-semester
nd to two- or three-quarter courses. It is assumed
udents will have junior standing at least and will
ave studied physical geology, historical geology,
nd possibly mineralogy.

The first chapter reviews basic concepts in biol-
gy, zoology, and paleontology. In addition, it con-
ins some controversial (and even some older dis-
redited) ideas which are pertinent to an understand-
g of paleontologic thought, even though the ideas
annot be classed as basic.

The remainder of the book is taken up systemat-
ally according to customary biologic classification.
niform endings are used for all taxa up through
uperorders. Definitions and illustrations clarify
e nature and limits of each taxon. In some sections,
orphologic information and illustrations are suf-
cient for readers to evaluate differences even at the
eneric and specific levels. In general, however,
e presentation concerns arrangement of fossils in
stratigraphic succession, or growth stages, or arbitrary morphologic series, or environmental adaptations, or their probable evolutionary progression. Only enough morphologic and zoologic information is presented in the systematic chapters to enable identification of members of the group or to enable recognition of one of the patterns of change in the group. Each of the foregoing patterns or series is not presented for each group. Instead, a particular series is utilized when an illuminating example of it is known. The amount of space allocated to the various systematic groups is governed in part by their usefulness in field work and by their suitability as teaching aids. For example, more space is devoted to foraminifers and brachiopods and less is devoted to sponges and cystoids than would be warranted by their relative taxonomic rank and their evolutionary significance.

Practically all stratigraphic information has been reduced to names of systems for the Paleozoic and Mesozoic rocks and of series for the Cenozoic rocks. Geologic ranges of fossils are illustrated with very simple abundance diagrams which are superimposed upon identical geologic time scales.

Illustrations have been selected not only for their morphologic value but also to depict common species from various geologic provinces in North America. Moreover, most of these species are readily available through purchase or exchange; therefore the illustrations can be utilized to advantage in laboratory work.--From auth. pref.

2-1146. Fox, William, and Samuel P. Welles. FROM BONES TO BODIES; A STORY OF PALEONTOLOGY: 118 p., illus., New York, H.Z. Walck, 1959.

Written for ages 10 to 14, this book shows how the paleontologist reconstructs extinct vertebrates. The first section, "The paleo-detective at work," points out the basic similarities of vertebrate skeletons, then discusses the importance of teeth, feet, and certain other bone structures in identifying and reconstructing fossil remains. The second section, "Case histories," describes the discovery and reconstruction of 3 famous creatures: the Shasta bison, Archaeopteryx, and Protoceratops.--M. W. Pangborn, Jr.

2-1147. Jeffords, Russell M., and T.H. Miller. AIR BRUSH FOR WHITENING FOSSILS, AND NOTES ON PHOTOGRAPHY: Jour. Paleontology, v. 34, no. 2, p. 275-276, pl., March 1960, 4 refs.

The use of a commercially available air brush for whitening fossils prior to photography is suggested as an advantageous technique. Other procedures that have been found useful in rapidly obtaining photographs of large suites of macrofossils are reviewed briefly.--Auth.

2-1148. Perry, T.G., and Joaquin Rodriguez. LECTOTYPE OF ANISOTRYPA SYMMETRICA ULRICH: Jour. Paleontology, v. 34, no. 2, p. 277-279, pl., March 1960, 2 refs.

A lectotype and lectoparatypes are selected for Anisotrypa symmetrica Ulrich, the type species of the bryozoan genus Anisotrypa Ulrich. The original specific description of Anisotrypa symmetrica is expanded.--Auth.

2-1149. Hoare, Richard D. NEW PENNSYLVANIAN BRACHIOPODA FROM SOUTHWEST MISSOURI: Jour. Paleontology, v. 34, no. 2, p. 217-232, 3 pls., March 1960, 41 refs.

Extensive collections made from the lower portion of the Cabaniss subgroup, the upper portion of the Krebs subgroup and deposits of Atokan age in southwest Missouri contain several new forms of Brachiopoda. The genus Desmoinesia is erected to contain specimens which have previously been included under the genus Marginifera but which lack the diagnostic features of the latter genus. This genus contains the species D. muricatina (Norwood & Pratten) and D. nana (Meek & Worthen). The genus Eolissochonetes, containing E. laevis (Keyes) and E. bilobatus n. sp., is erected for specimens which are transitory between the genera Mesolobus and Lissochonetes.

Also among the Productacea Dictyoclostus tiawahensis, n. sp., Linoproductus planiventralis, n. sp., L. echinatus, n. sp. and L. distortus, n. sp., are described. Composita tetralobata, n. sp., is erected in the family Arthyridae.--Auth.

2-1150. Cooper, G. Arthur. GENERA OF TERTIARY AND RECENT RHYNCHONELLOID BRACHIOPODS: Smithsonian Inst., Smithsonian Misc. Colln., v. 139, no. 5, 90 p., figs., 22 pls., Nov. 1959, 75 refs.

The Tertiary and Recent brachiopods of North America are described and classified. Representatives of some species outside of North America ar included as available and adequately described for classification. Rhynchonelloid classification depen to a great extent on interior details. The present classification includes 6 families, 3 subfamilies, a 22 genera. The following are new: families Basiliolidae, Frieleiidae, Hispanirhynchiidae, and Eryn ariidae; subfamilies Basiliolinae, Aphelesiinae, an Aetheiinae; genera Probolarina, Streptaria, Aphele Notosaria, Grammetaria, Sphenarina, and Erymnaria; species Cryptopora rectimarginata, Basiliola elongata, Eohemithyris? gettysburgensis, Streptari streptimorpha, and Erymnaria cubensis.--M. Russ

2-1151. Zimmerman, James A., PLEISTOCENE MOLLUSCAN FAUNAS OF THE NEWELL LAKE DEPOSIT, LOGAN COUNTY, OHIO: Ohio Jour. Sci v. 60, no. 1, p. 13-39, 19 figs., Jan. 1960.

The Newell Lake deposit lies in a buried kame field in Union Township. Detailed analysis of the molluscan faunas of the marl and peat deposits, wit emphasis on quantitative distribution, demonstrates changes in environment. The faunas were collecte at 2-in. intervals in a vertical section 12 in. square Additional samples were taken from other places in the deposit from which the stratigraphy was determined. The marl was washed from the samples, the remaining organic material was dried, and the Mollusca sorted and identified. Approximately 1,00 individuals were picked at random from each 2-in. collection. The specific assemblage and the percen age of each species was determined; the volume of total Mollusca and of the other organic material (primarily vegetation and shell fragments) was mea ured, and the total molluscan population in each col lection was calculated. Analysis of these data yield the quantitative distribution of each species and sho those that are considered indigenous, by virtue of their relative abundance, to the area of the collections within the deposit. On the basis of specific ecology and quantitative distribution, the changes in environment to shallower water with an increase in vegetation during the period of deposition at the site of the collections and the changes in the position of the shoreline of the lake were determined. The faunas of the Newell Lake deposit are compared wit several other faunas, both living and fossil. The Newell Lake deposit is assigned a Wisconsin age on the basis of the faunas discussed and the presence o extinct species (Amnicola leightoni, Helisoma anceps striatum, Gyraulus altissimus, and Fossari obrussa decampi). Surrounding surficial deposits and faunas compared suggest that the earliest date for initial development of the lake was late Wiscons --Auth.

2-1152. Clark, David L. PARAPUZOSIA IN THE NORTH TEXAS CRETACEOUS: Jour. Paleontology v. 34, no. 2, p. 233-236, pl., 3 diags., March 196 16 refs.

Parapuzosia (Parapuzosia) has been found in the uppermost Austin chalk [Cretaceous] in Ellis, Dalla and Collin counties in northern Texas where it is ar excellent stratigraphic marker. Fragments of Parapuzosia (Austiniceras), found in Cenomanian ar Turonian rocks of Europe, have been reported from Texas, and now the first Texas species is recorde from the upper Eagle Ford shale S. of Dallas.--Aut

2-1153. Tasch, Paul. CONCHOSTRACAN GENUS ANOMALONEMA IN THE AMERICAN PENNSYLVANIAN: Jour. Paleontology, v. 34, no. 2, p. 285-289, pl., table, March 1960, 8 refs.

A new conchostracan species, Anomalonema (Pierrepruvostia) williamsii is described from the shale above the Upper Kittanning coal, Clearfield County, Pennsylvania. This is the first representative of the genus found outside the coal fields of northern France. Novojilov's new genus, Pierrepruvostia, is reduced to subgeneric status, and his subfamily Anomalonematinae is rejected. Two new subgenera of the genus Anomalonema are proposed: Pierrepruvostia and Anomalonema. The former lacks postero-dorsal recurvature and has a nonterminal beak; the latter has postero-dorsal recurvature and a terminal beak. Both subgenera share the generic character of tubercles (interrupted radial lirae) margining growth lines. This feature gives a scalloped appearance to growth line peripheries. Raymond's questionable assignment of Chernyshev's specimens to the Anomalonema is rejected, and these specimens are assigned to the Estheriella. The inferred relationship between Pruvost's "tubercles" and "indentations" on the new species is supported by measurements of distance between any 2 adjacent pairs of each. Almost complete agreement was found between these sets of figures. Comparison with measurements on valves of the living species Caenestheriella belfragei establishes the fact that distances between any 2 adjacent spines or setae bases is a hundredfold less than between any 2 tubercles or indentations. These data indicate that the latter features are "interrupted radial lirae" and could not have been spines or setae bases in the living animal.--Auth.

2-1154. Hibbard, Claude W., and Walter W. Dalquest. A NEW ANTILOCAPRID FROM THE PLEISTOCENE OF KNOX COUNTY, TEXAS: Jour. Mammalogy, v. 41, no. 1, p. 20-23, fig., Feb. 1960, 7 refs.

The presence of a new species of mammal, an antilocaprid, distinct from previously reported remains, is recorded from the sand and gravel of the Seymour formation, below the Pearlette ash horizon, belonging to the Gilliland local faunule of late Kansan (2nd glacial) age. The specimen was collected along the N. valley wall of the S. Wichita River, Knox County, Texas.

The specimen is designated as a new species and is placed questionably in the genus Tetrameryx. This specimen, Tetrameryx? knoxensis, is compared with Tetrameryx shuleri Lull, T. irvingtonensis Stirton, Stockoceros conklingi Stock, and S. onusrosagris (Roosevelt and Bruden).--J. J. Stephens.

2-1155. Noback, Charles R. THE HERITAGE OF THE HUMAN BRAIN: 30 p., 5 illus., chart, New York, American Museum of Natural History, 1959, 35 refs.

A lecture presented as one of the series "James Arthur Lectures on the Evolution of the Human Brain." Vertebrate brains are remarkably diverse in structure and function; they are probably the most plastic structure in animals. Nerve fibers that cross over in the optic chiasma have their counterparts in all vertebrates; this can be traced back to the Ordovician. Uncrossed nerve fibers in the optic chiasma are found only in the mammals; this can be traced back only to the Paleocene. The coordinating mechanisms associated with the eye's reflex patterns persist in the tectum of the human midbrain, an old heritage, but the substrates for visual perception have shifted to the lateral geniculate body and cerebral cortex, namely encephalization, a newer heritage. The pyramidal system, which plays a significant role in the motor activity of the hand with opposable thumb is found only in mammals, a newer heritage. The integrating mechanisms of our basic drives such as sleep and emotion are in the reticulate system and allocortex of man and have a long phylogenetic history. The cellular substrates of the long lemniscal systems, concerned with specific sensory modalities, and the neocortex, newer heritages, are probably derived from the older multineuronal reticular system. An expression of interaction between the paleocortex and neocortex occurs in certain epileptic seizures where a state of confusion is followed or associated with a moment of speech difficulty. The concept of adaptive radiation is demonstrated by the diversity of certain structures in the nervous system. Although man's evolution in the past 200,000 years or so has been primarily due to the aids of civilization, the human brain will probably continually change over the millions of years to come in accordance with the principles of natural selection.--From auth. summ.

2-1156. Trujillo, Ernest F. UPPER CRETACEOUS FORAMINIFERA FROM NEAR REDDING, SHASTA COUNTY, CALIFORNIA: Jour. Paleontology, v. 34, no. 2, p. 290-346, 8 pls., 2 maps, chart, 2 tables, March 1960, 28 refs.

Three Late Cretaceous shale units cropping out in the northern Great Valley have been sampled for foraminiferal content. Approximately 2,500 ft. of section is represented in association with 1,500 ft. of sandstone. Ninety species of Foraminifera - 22 of which are new - are illustrated, described, and their stratigraphic ranges determined. One new name is proposed. Two distinctive faunas are recognizable, the division coinciding approximately with the Turonian-Senonian boundary. Arenaceous species constitute the greater number of individuals, while for stratigraphic purposes the Orbulinidae - especially the genus Globotruncana - are dominant in the Turonian, and they, with the Rotaliidae, are of greatest importance in the Senonian. Most of the species have been previously reported from the European and Gulf Coastal regions. An interpretation of the paleoecology indicates a sublittoral zone as the site of deposition for associated sediments. On the basis of foraminifers and diagnostic megafossils, the ages of the units are determined as middle Turonian, Coniacian, and Santonian.--Auth.

2-1157. Hooper, Kenneth. THE GENUS OPERCULINA IN AUSTRALIA, A LITERATURE SURVEY: 1826-1958: Carleton Univ., Dept. Geology, Geol. Paper 59-1, 6 p., illus., 1959, 20 refs.

Study of the literature shows that the genus Operculina is still unsatisfactory, taxonomically. It is very variable. However, variation ascribed to the Australian species O. victoriensis seemed so extreme that it was decided to investigate, statistically. The results will be reported later.--Auth. concl.

2-1158. Ethington, R. L., and W. M. Furnish. UPPER ORDOVICIAN CONODONTS FROM SOUTHERN MANITOBA: Jour. Paleontology, v. 34, no. 2, p. 265-274, pl., table, March 1960, 31 refs.

Conodonts have been secured in moderate abundance from the Stony Mountain formation at the type locality. Age of these strata has been previously established as Upper Ordovician on the basis of a varied megafauna. The conodonts are similar to others known from northern Manitoba, western and midwestern United States. Although there are some 30 species identified from the Stony Mountain, only 2 are described as new. Some are of long-ranging types; others verify correlation of this fauna with the Upper Ordovician of widely separated areas. In particular, representatives of Belodina, Cordylodus, Cyrtoniodus, Eoligonodina, Plegagnathus, and Pristognathus appear significant.--Auth.

2-1159. Pulse, Richard R., and Walter C. Sweet. THE AMERICAN UPPER ORDOVICIAN STANDARD III. CONODONTS FROM THE FAIRVIEW AND McMILLAN FORMATIONS OF OHIO, KENTUCKY AND INDIANA: Jour. Paleontology, v. 34, no. 2, p. 237-264, 3 pls., map, diag., table, March 1960, 22 refs.

The Fairview and McMillan formations of the Cincinnati region, the reference standard for the North American Maysville stage (Upper Ordovician), have yielded a large collection of conodont elements, referable to 29 species, distributed among 18 genera. Fourteen species are known to range through the Eden, Fairview, and McMillan formations; most of these are represented as well in late Mohawkian and Trentonian strata in the midcontinent province of North America, and several continue into the Richmond group. Three species in the Fairview fauna occur also in the Eden, but do not range above the Fairview locally; 7 species are restricted to the Fairview. Four species, introduced locally in late Eden or early Fairview strata, continue into the McMillan, which otherwise contains a reduced fauna of long-ranging midcontinent species. The presence of Ambalodus, Amorphognathus, and Belodina in Eden and Fairview strata, but not above them, suggests that the Orchard Creek shale of Missouri, the pre-upper Brainard Maquoketa shale of Iowa, and the Maravillas formation of Texas (which have all yielded representatives of these genera) are Maysville in age, or older. Four species (Eoligonodina fairmountensis, Oulodus casteri, Prioniodina velicuspis, and Zygognathus maysvillensis) are described for the first time.--Auth.

2-1160. Hart, C.W., Jr. THE OSTRACODS OF THE GENUS ENTOCYTHERE FROM THE LOWER CHATTAHOOCHEE-FLINT BASIN: WITH A REVIEW OF THE OCCURRENCE OF THE GENUS IN FLORIDA AND DESCRIPTIONS OF TWO NEW SPECIES: Florida State Mus., Bull., Biol. Sci., v. 4, no. 6, p. 193-204, 19 figs., May 1959, 3 refs.

During a systematic survey of the flora and fauna of the Apalachicola River drainage area supported by the U. S. National Park Service and the National Science Foundation, those ostracods epizoic on crayfishes were studied. A key to the known species of entocytherid ostracods found in Florida and the lower Chattahoochee-Flint basin, a survey of the ranges of these ostracods, a list of their crayfish "hosts," and descriptions of 2 new ostracod species are included. The new species, Entocythere geophila and E. torreya, are placed in a new group, the Geophila group, which is here designated.--Auth.

2-1161. Bhatia, S.B., and N.K. Mandwal. BURDIGALIAN OSTRACODA FROM THE SURAT-BROACH AREA, WESTERN INDIA: Jour. Paleontology, v. 34, no. 2, p. 280-284, pl., March 1960, 7 refs.

Fourteen species of Ostracoda are recorded and illustrated from the Miocene (Burdigalian) of the Surat-Broach area, western India. These include one new species - Actinocythereis levinsoni. The fauna shows affinities with both the European and the Indo-Pacific forms.--Auth.

2-1162. Cropp, Frederick W. PENNSYLVANIAN SPORE FLORAS FROM THE WARRIOR BASIN, MISSISSIPPI AND ALABAMA: Jour. Paleontology, v. 34, no. 2, p. 359-367, map, 3 charts, 2 secs., March 1960, 7 refs.

A study of macerated coals from 3 wells in Mississippi which penetrated the Pennsylvanian section indicates that spores, which are potentially useful in correlation from one area to another, can be isolated from regular well cuttings. No definite correlations can be made between the coals from the 3 wells and the outcrop samples from Walker County, Alabama, on the basis of the spore assemblages of the coals chosen for this study, but spores present in the Alabama and Mississippi samples indicate that all the coals are Pottsville in age. The spores present in the lowermost coals of the Young-Henderson well provide information extending the stratigraphic range of several genera farther into the lower Pennsylvanian in North America. This information corresponds in most cases with information published by Potonié & Kremp from Europe and Asia.--Auth.

6. GEOPHYSICS

See also: Geologic Maps 2-1045; Mineral Deposits 1-1253.

2-1163. Ahrens, L.H., Frank Press, Kalervo Rankama, and S.K. Runcorn, eds. PHYSICS AND CHEMISTRY OF THE EARTH. [V.] 3: 464 p., maps, secs., diags., graphs, profiles, tables, New York, Pergamon Press, 1959, refs.

This is the third and most recent volume in an annual series. A principal aim of the series is to provide authoritative and up-to-date surveys of progress for those actively engaged in geophysics and geochemistry. It is hoped also that much of what is written will encourage the interest of the chemist and physicist in a study of our planet, not merely for its own sake, but because such a study often turns out to be of benefit to physics and chemistry. Another aim is to acquaint the geologist with the results and methods of geophysics and geochemistry, particularly as progress in earth science has been hindered by some lack of liaison between different groups. The subject matter coming under the heading of physics and chemistry of the earth is vast, and only a limited number of topics can be considered in a given volume; in general, an attempt will be made to provide a balanced variety of topics with roughly equal emphasis on chemistry and physics.--From pref. to v. 1.

The 8 papers in v. 3 are listed below. They are in the appropriate subject sections of this issue of GeoScience Abstracts.

Durham, J. Wyatt. PALAEOCLIMATES, p. 1-16.

Officer, Charles B., J. I. Ewing, J. F. Hennion, D. G. Harkrider, and D. E. Miller. GEOPHYSICAL INVESTIGATIONS IN THE EASTERN CARIBBEAN: SUMMARY OF 1955 AND 1956 CRUISES, p. 17-109.

Drake, Charles L., Maurice Ewing, and George H. Sutton. CONTINENTAL MARGINS AND GEOSYNCLINES: THE EAST COAST OF NORTH AMERICA NORTH OF CAPE HATTERAS, p. 110-198.

Cameron, A. G. W. THE ORIGIN OF THE ELEMENTS, p. 199-223.

Roedder, Edwin. SILICATE MELT SYSTEMS, p. 224-297.

Adams, John A. S., J. Kenneth Osmond, and John J. W. Rogers. THE GEOCHEMISTRY OF URANIUM AND THORIUM, p. 298-348.

Tomkeieff, S. I. GEOCHEMISTRY IN THE U.S.S.R. (1954-1956), p. 349-413.

Tozer, D. C. THE ELECTRICAL PROPERTIES OF THE EARTH'S INTERIOR, p. 414-436.

2-1164. Gutenberg, Beno. LOW-VELOCITY LAYERS IN THE EARTH, OCEAN, AND ATMOSPHERE: Science, v. 131, no. 3405, p. 959-965, 7 figs. incl. map, diags., graphs, Apr. 1, 1960, approx. 6 refs.

The article begins with an introduction to Fermat's principle, which states that waves (elastic) follow a path which makes their transmission time between 2 points a minimum. This principle can easily be applied to the earth itself, and in doing so evidence of several peculiar phenomena such as shadow zones, "caustics," and "channels," which are paths or areas of wave concentration or rarifaction, is given. Following the evolution of thinking with regard to various layers in the earth from 1906 to the present, Dr. Gutenberg presents the basis for the present-day concepts we have of the earth's interior. The presence of the "asthensphere channel" and low velocity channels in the lithosphere as well as similar channels in air and water have been described, and many hitherto unexplained phenomena have been accounted for by the results of this line of thought.--B. C. Schreiber.

2-1165. Abelsky, M. E. DETERMINATION OF THE MOMENT OF INERTIA AND THE CENTRIFUGAL MOMENT OF THE TORSIONAL WEIGHTS OF THE GRAVITATIONAL VARIOMETER S-20: Akad. Nauk SSSR, Bull., Geophysics Ser., in translation, 1958, no. 7, p. 526-527, illus., diag., pub. Nov. 1959, ref.

The numerical values of the moment of inertia $\underline{K}$ and of the centrifugal moment $\underline{M}$ of a torsion weight of a variometer enter into the calculation of the second derivatives of the gravitational potential and are usually given by the manufacturer on the rating plate of the instrument, as it is difficult to compute these characteristics when the instrument is fully assembled. Abelsky suggests a method of experimental determination of these values, when this becomes necessary. He starts from the equations defining the moments $\underline{K}$ and $\underline{M}$, $\underline{K} = \int (x^2 - y^2)\, \underline{dm}$, $\underline{M} = \int \underline{xz}\, \underline{dm}$. These integrals are to be taken over the entire volume of the balance beam. The values of $\underline{K}$ and $\underline{M}$ in the system of coordinate axes with the same zero point and forming an angle $\underline{a}$ with the first system will be: $\underline{K} = \int x_1^2 \cos^2 \underline{a}\, \underline{dm}$, $\underline{M} = \int x_1^2 \sin \underline{a} \cos \underline{a}\, \underline{dm}$. From these equations we have $\underline{M} = \underline{K} \tan \underline{a}$. On the other hand $\underline{K} = \underline{r} \frac{T^2}{4\pi^2}$ where $\underline{r}$ is the torsional rigidity of the fiber supporting the instrument and $\underline{T}$ the period of its vibration; in the variometer investigated $\underline{r} = 89.314$ g.per cm.^{2} per sec.^{2}, therefore $\underline{K}_1 =$ 8,850 g.per cm.^{2}, $\underline{M}_1 =$ 13,250 g.per cm.^{2}; and $K_{11} =$ 8,730 g.per cm.^{2}, $\overline{M}_{11} =$ 13,080 g.per cm.^{2} The same problem can be solved in the polar system of coordinates; such a solution is also given.--S. T. Vesselowsky (courtesy Geophysical Abstracts 176-187).

2-1166. Brunelli, B. E., D. A. Nizyaev, and Kh. D. Kanonidi. A MAGNETIC FIELD STABILIZER: Akad. Nauk SSSR, Bull., Geophysics Ser., in translation, 1958, no. 7, p. 523-525, 4 diags., pub. Nov. 1959, 2 refs.

At present, precise magnetic measurements must be made at points sufficiently remote from urban and industrial centers due to the intense disturbances usually found there. A description is given of a magnetic stabilizer capable of preserving the intensity of the geomagnetic field even under very unfavorable local conditions. An instrument similar to a magnetometer is used, having a built-in photoelectric attachment instead of a measuring scale. This is so adjusted that upon deflection of the magnetometer beyond a certain limit, a beam of light falls on a photosensitive element; this produces a current which is sent into a Helmholtz coil. It is essential to create conditions of proportionality between the variation of the magnetic field and the intensity of the correcting current. A description is given of several devices built on this principle. In the geomagnetic laboratory of the University of Leningrad variations of the magnetic field, ranging from 60 to 100γ before the installation of the magnetic stabilizer were reduced to ±2 to 3γ. In the Scientific Arctic Institute of Leningrad a stabilizer was installed in a room facing a street with heavy electric street car traffic, causing magnetic field variations as high as 1,500γ; after the installation, this variation did not exceed ±5γ -- S. T. Vesselowsky (courtesy Geophysical Abstracts 176-252).

2-1167. Kalashnikov, A. G. MAGNETIC PROPERTIES OF NON-UNIFORMLY MAGNETIZED PRISMS. II: Akad. Nauk SSSR, Bull., Geophysics Ser., in translation, 1958, no. 11, p. 771-775, 8 diags., 3 graphs, table, pub. Dec. 1959, 4 refs.

The results of the study of the distribution of residual magnetism, averaged over a cross section, along the axis of a prism by using the method of elimination of the demagnetizing field are discussed. This distribution is then confronted with the topography of the external field of the prism and of the cube.--Auth.

2-1168. Komarov, A. G. ON THE PROBLEM OF THE AGE OF THE GABBRO-PERIDOTITE FORMATION IN THE URALS. Translated by Dorothy B. Vitaliano: Internat. Geology Rev., v. 2, no. 2, p. 138-143, 5 tables, Feb. 1960, 12 refs.

In this paper it is confirmed by means of study of the magnetic properties that the pebbles of igneous rock from the Eifelian conglomerates of the Pri-Polar Urals are derived from the Pt-bearing gabbro-peridotite formation, and its age is established as Caledonian. In the author's opinion mass measurement of magnetic properties and statistical analysis of the results permits the use of comparison of the value of the vector of remanent magnetization as a supplementary criterion for age correlation of igneous rocks.--Auth.

2-1169. Bower, Margaret E. GEOPHYSICAL INTERPRETATION OF THE MAGNETIC ANOMALY AT MARMORA, ONTARIO: Canada, Geol. Survey, Paper 59-4, 11 p., 9 maps, sec., profile, graph, table, 1960, 2 refs.

Aeromagnetic survey of part of southern Ontario showed a very intense magnetic anomaly near the town of Marmora. Ground exploration indicated that this anomaly was caused by an ore body containing 20 million tons of material averaging 35% Fe. A series of experimental flights were made over this anomaly to determine the effect of various altitudes on the intensity and dimensions of the anomaly. Lines were flown in a N.-S. direction at a spacing of 1/4 mi. and flights were made at heights of 5,000, 2,000, 1,000, 500, 400, 300, 200, and 100 ft. above the ground level. Some interpretation of the results of these flights are given in this paper. Several methods of determining the grade and tonnage of the ore body from the magnetic data were tried, but the results were not in agreement with known values.--P. Harker.

2-1170. Ozertsova, V.A., L.V. Polyakova, and T.N. Spizharsky. RELIEF OF THE CRYSTALLINE BASEMENT IN THE SOUTHEASTERN PART OF THE SIBERIAN PLATFORM FROM AEROMAGNETIC SURVEY DATA. Translated by Research International Associates: Internat. Geology Rev., v. 2, no. 2, p. 103-106, map, sec., Feb. 1960, 2 refs.

The topography of the crystalline basement of the southeastern Siberian platform is described. Control for the contours is a total of 2,000 depth determinations computed from aeromagnetic survey data. The interpretation suggested includes 2 principal structural elements: Aldan anteclise and Vilyuy syneclise. The N.-dipping Aldan anteclise outcrops to the S. A number of minor troughs and folds are developed on major structures.--Research International.

2-1171. Tozer, D.C. THE ELECTRICAL PROPERTIES OF THE EARTH'S INTERIOR (In: Ahrens, L.H., and others, eds. Physics and Chemistry of the Earth. [V.] 3: p. 414-436, 5 diags., 5 tables, New York, Pergamon Press, 1959) 34 refs.

The methods by which knowledge of the electrical properties of the mantle and core have been obtained are described. The arbitrary nature of conductivity distributions found from the geomagnetic field variations is mentioned and, in particular, reasons are given for suspecting that first order discontinuities in the conductivity distribution do not occur.

It is shown that although the ultrabasic minerals exhibit both electronic semiconduction and ionic conduction at atmospheric pressure, the mantle below a few hundred kilometers may be treated as an electronic semiconductor. At shallower depths in the mantle the ionic conductivity is comparable with the electronic conductivity.

A derivation of the temperature distribution from the conductivity distribution is given, assuming the mantle is composed mainly of a Mg-rich olivine (~90% Mg_2, SiO_4). This shows a steepening of the temperature gradient in the transition region between depths of 400 and 900 km. A number of explanations of this are given which are based on different models of the heat transfer process in the mantle. It is also shown that the rapid rise in conductivity in the neighborhood of 700 km. cannot be interpreted as evidence for or against a compositional change. A temperature of 4,500°K. which is uncertain by several hundred degrees is suggested for the core-mantle boundary. The Hall coefficient and thermoelectric power are estimated in the lower mantle. A maximum value of 300 $\mu V/^{o}C$ is suggested for the thermoelectric power of an olivine mantle, which is rather lower than previous estimates.

The various methods of estimating the conductivity of the core are described and attention is drawn to the considerable uncertainty due to materials dissolved in the Fe. A value between 10^3 and 10^4 Ω^{-1} cm^{-1} is most probable.--Auth. concl.

2-1172. Khalfin, L.A. CAUSALITY PRINCIPLE AND CRITERION OF PHYSICAL FEASIBILITY IN CLASSICAL ELECTRODYNAMICS AND THEORY OF SIGNAL PROPAGATION. I: Akad. Nauk SSSR, Bull., Geophysics Ser., in translation, 1958, no. 11, p. 731-737, 12 diags., pub. Dec. 1959, 15 refs.

General consequences of the causality principle in classical electrodynamics and theory of signal propagation are considered. Besides the "dispersion" relationships of Kramers-Kronig, a criterion of physical feasibility based on the fundamental Paley-Wiener theorem is discussed.

There are restrictions which follow from the application of the causality principle to electrodynamic parameters of a medium (dielectric constant and magnetic permeability, conductivity) which by assumption are functions of frequency, as well as restrictions concerning the admissible absorption and dispersion properties of media (in propagation of electromagnetic and seismic signals). These restrictions are of basic importance for the development of geophysical methods, especially of those utilizing the dynamic characteristics of signals.--Auth.

2-1173. Ananyan, A.A. DEPENDENCE OF ELECTRICAL CONDUCTIVITY OF FROZEN ROCKS ON MOISTURE CONTENT: Akad. Nauk SSSR, Bull., Geophysics Ser., in translation, 1958, no. 12, p. 878-881, 4 graphs, 5 tables, pub. Jan. 1960, 8 refs.

The electrical conductivity in finely dispersed frozen rocks is governed by the progressive advance of the not yet frozen portion of the water. The electrical conductivity of such rocks is determined by the phase relations of the water. The smaller the amount of ice and the larger the amount of unfrozen water, the higher the electrical conductivity. The conductivity. The conductivity of the frozen rocks reaches its maximum when the moisture content approaches the lower limit of plasticity.--S. T. Vesselowsky (courtesy Geophysical Abstracts 177-142).

2-1174. Dedysheva, T.V., V.B. Pigulevskaya, and P.F. Rodionov. ON THE APPLICABILITY OF COMPENSATION METHODS OF ELECTRIC EXPLORATION TO PROSPECTING PYRITIC DEPOSITS OCCURRING IN THE MIDST OF METAMORPHIC ROCKS AND SHALES IN THE URAL: Akad. Nauk SSSR, Bull., Geophysics Ser., in translation, 1958, no. 11, p. 792-796, 6 figs., pub. Dec. 1959, 6 refs.

A comparative study of field data obtained from electric geophysical prospecting in the central Ural, a series of examples thereof having been described in this paper, permits one to make the following conclusions.

1) Because of the nonuniform depth of porous overburden, studies in the field based on compensation

ethods fail in practice to achieve more or less
iform fields. As a consequence, one sometimes
es not trace out the anomalies which are character-
ic of localized conducting bodies, even above shal-
w-lying ore bodies (Yuryev, Slonov, and Shaitan
posits). The inhomogeneity of the field often makes
difficult to determine the location of the conducting
dy, and many details of its structure which are of
portance in prospecting, are lost.

2) Bands of metamorphic rocks and shales, as a
le, give rise to anomalies in the compensation
ethods, which are not different from anomalies
at are associated with ore bodies.

3) The small separation between the electrodes
d the strong influence of grounding conditions
used by bands of shales makes it difficult to sep-
ate out regions of increased or decreased electri-
l conductivity, even in upper levels (less than
m). Consequently, if one depends on an indirect
nnection between deep-lying ore bodies and such
nducting regions, then the compensation method
d its variant, the vertical field method, cannot be
ed for indirect surveying of deep-lying ore bodies.
the other hand, the uncovering of deep-lying ore
dies by bore-testing conductivity anomalies de-
cted by the isoline method was demonstrated, as
s been done in the Pyanko-Lomov and Teplov
posits.

4) Separating out small intensity anomalies (of
e order of 10%), directly associated with deeply-
ng ore bodies, even when these lie at a depth of
to 100 m, is impossible in the presence of strong
stortions of the field caused by metamorphic rocks
d shales, with the added complication of the elec-
cal inhomogeneity of these rocks.

From these data it follows that the conclusions
ached by I. K. Ovchinnikov from the data of the
rabash region concerning the limited possibilities
prospecting deep-lying ore bodies by the compen-
tion method are valid in all regions in the central
al, and that the compensation method and the ver-
al field method are generally unsuitable for pros-
cting deep-lying pyritic ore bodies lying in the
dst of metamorphic rocks and shales.

These methods are also unsuitable for prospecting
allow-lying (less than 50 m) ore bodies, which are
sociated with streaks of metamorphic rocks and
ales, for the following reasons: a) because of the
ficulty of separating out localized anomalies
ainst a background of general distortion of the
ld, caused by these very shales; b) because of the
ccuracy in locating the conducting bodies; and
because of the larger cost (by a factor of 3 or 4)
field work as compared to work by the isoline
ethod, or by the combined profiling methods.

For the reasons cited above, application of the
mpensation method and the vertical field method
prospecting pyrite deposits in the Ural should be
nerally abandoned, when such deposits are located
the midst of metamorphic rocks and shales.--Auth.
ncl.

**175. Kirnos, D.P., and N.V. Kondorskaya.
MPUTATION OF THE TRUE VALUE OF THE
RST AMPLITUDE OF GROUND PARTICLE MO-
N AT THE ARRIVAL OF A SEISMIC WAVE: Akad.
uk SSSR, Bull., Geophysics Ser., in translation,
58, no. 12, p. 840-844, 9 figs. incl. diags., graphs,
. Jan. 1960, 2 refs.**

The study of earthquake mechanism, the use of
amic properties of seismic waves in investigations
the internal structure of the earth, as well as some other problems of modern seismology make it imperative to know the initial amplitude of the displacement of the ground on the arrival of a seismic wave. This displacement is always recorded with some distortion which necessitates knowing the dynamic magnification of the seismographs especially during the first wave. Methods of evaluating the initial amplitude of seismograms are discussed, and graphs for this purpose are given. The results of theoretical computations are compared with the observed values. For this purpose seismograms of more than 100 earthquakes in different regions of the U. S. S. R., with epicentral distances ranging from 0° to 150°, have been analyzed. Agreement between the computed and the observed values was found to be satisfactory for $\underline{P}$ waves when Δ did not exceed 20° and foci were not too shallow.--S. T. Vesselowsky (courtesy Geophysical Abstracts 177-62).

2-1176. Solovev, S.L. AMPLITUDE VARIATIONS WITH DISTANCE IN THE GROUND PARTICLE MOTION OF SURFACE WAVES OF KURILO-KAMCHATKA EARTHQUAKES: Akad. Nauk SSSR, Bull., Geophysics Ser., in translation, 1958, no. 11, p. 762-770, 4 diags., 3 tables, pub. Dec. 1959, 4 refs.

A study on the variability with distance of the displacement and velocity of the ground particle motion of surface waves during Kurilo-Kamchatka earthquakes. It was found that these quantities do not decrease but that they increase during the transition from the Far Eastern to the continental stations, located at greater epicentral distances. On either side of this anomalous zone the quantities decrease with distance in accordance with the laws established previously for earthquakes occurring in the continental areas.--Auth.

2-1177. Savarensky, E.F., and Sh. S. Ragimov. DETERMINING THE VELOCITY OF RAYLEIGH WAVES AND DIRECTION TO THE EPICENTER BY THREE NEARBY STATIONS: Akad. Nauk SSSR, Bull., Geophysics Ser., in translation, 1958, no. 12, p. 866-869, 4 graphs, log, 4 tables, pub. Jan. 1960, 7 refs.

The accuracy of determinations of group velocity of Rayleigh waves can be estimated only by comparison of data of 3 neighboring stations, where the distance between them is so small with respect to the epicentral distance that the wave paths are essentially parallel. Because of the effect of lateral refraction, observations at 3 neighboring stations also provide a check of the accuracy of determination of epicenters by means of longitudinal wave arrivals; for this purpose it is necessary that the dynamic parameters of the instruments at all stations be as identical as possible, so that the differences in similar readings are smaller than the tolerable error. Data from 3 Caucasian stations (Goris, Kirovabad, and Shemakha) each equipped with a 3-component Kirnos seismograph, are used to illustrate the determination of group velocities of Rayleigh waves using 4 1957 earthquakes (March 17, 22, and 29 in the Aleutians and Oct. 25 in the Kurile Islands). From data from the same stations, epicentral directions are determined for these and 1 other earthquake (Apr. 10, 1957). In conclusion it is remarked that the ratio of the differences of epicentral distances to differences in arrival time for oscillations of approximately the same period at 2 stations is equal to the phase velocity of Rayleigh waves of that period; this is illustrated by the examples of the earthquakes of

Apr. 14, 1957, (Samoa) and July 28, 1957, (southern Mexico).--S. T. Vesselowsky (courtesy Geophysical Abstracts 177-68).

2-1178. Ivakin, B.N. ON MODELING OF ABSORPTION OF SEISMIC WAVES: Akad. Nauk SSSR, Bull., Geophysics Ser., in translation, 1958, no. 7, p. 468-474, 5 diags., pub. Nov. 1959, 42 refs.

General methods for the construction of continuous mechanical and elastic models of imperfectly elastic media are discussed. Such models are determined for imperfectly elastic media characterized either by afterworking effect, or by viscosity (inner friction), or by residual deformations. Equations of the motion for such models are established as well as formulas for the resistance to wave motion propagating through such media. The application of such models in experimental mechanics for the solution of different problems not amenable to analytical methods are discussed. In the treatment of the problems the only assumption made is that the media in which the waves are propagating are not perfectly elastic but are ideally inert, that is, the entire consumption of energy is caused by the imperfect elasticity of the medium, its density remaining independent of the absorption of energy.

Operational methods are used in the treatment of the problems. Many references to studies of both Russian and western scientists are given.--S. T. Vesselowsky (courtesy Geophysical Abstracts 176-82).

2-1179. Chekin, B.S. ON A SPECTRUM OF WAVES, REFLECTED AND REFRACTED BY A PLATE: Akad. Nauk SSSR, Bull., Geophysics Ser., in translation, 1958, no. 11, p. 738-742, 13 diags., pub. Dec. 1959, 3 refs.

Approximate formulas are derived which hold in the vicinity of a wave front and characterize the transformation of a spectrum of an incident longitudinal spherical wave reflected and refracted by a plate. It is assumed that longitudinal waves only are propagating in the medium.--Auth.

2-1180. Ivakin, B.N. THE CALCULATION AND MODELING OF THE ABSORPTION OF SEISMIC WAVES: Akad. Nauk SSSR, Bull., Geophysics Ser., in translation, 1958, no. 11, p. 743-754, 9 graphs, 8 seismograms, tables, pub. Dec. 1959, 14 refs.

On the basis of the results of the preceding paper [see Chekin abstract above], calculations of the velocity of propagation, the coefficient and decrement of absorption of elastic waves and the acoustic impedance as a function of frequency are carried out for absorptive media and their models: 1) with elastic afterworking of the Sokolov-Skryabin type, 2) with viscosity (internal friction), 3) with residual deformation. The results of the calculations for absorbing media are discussed; the criteria for similarity for the effects of absorption on elastic waves are considered; the results of experimental investigations of the absorbing properties of media mentioned above by electrical models are presented for pulses and sinusoidal oscillations.--Auth.

2-1181. Yanovskaya, T.B. THE DISPERSION OF RAYLEIGH WAVES IN A SPHERICAL LAYER: Akad. Nauk SSSR, Bull., Geophysics Ser., in translation, 1958, no. 7, p. 461-467, 4 diags., pub. Nov. 1959, 12 refs.

Ewing and Press have reported Rayleigh waves with wave lengths of more than 2,000 km. As the ratio of wave length to radius of the earth is therefc not negligible, theoretical calculations of wave propagation in the earth must take into account the sphericity of the earth. This paper is a mathematical analysis of Rayleigh wave dispersion based on the assumption that the waves are propagating in a sphe ical layer overlying a homogeneous elastic sphere. The elastic constants for the upper layer and for the sphere are given. It is assumed that waves are produced by a fixed constant source having a frequency p. The problem consists of the evaluation of the displacement vectors U_1 and U_2 in the layer and in the sphere; these vectors must satisfy the correspondin wave equations. The boundary conditions are the equality of stresses and displacements on the boundary surface and on the surface separating the layer from the sphere. The solutions of the wave equation expressed in spherical coordinates can be found mo conveniently when they are developed in spherical harmonics. Furthermore the stress-vector Fr on the spherical surface can be expressed in terms of the divergence and the curl of the vector U. The solutions are obtained after introduction of Legendre functions and rather cumbersome transformation of the determinant resulting from these. Yanovskaya finally expresses the velocity v of the waves in the spherical layer in terms of the velocity v_o in the plane layer; v_o was determined by Keylis-Borok for more simple conditions of the problem.--S. T. Vesselowsky (courtesy Geophysical Abstracts 176-81).

2-1182. Radzhabov, M.M. DETERMINATION OF BOUNDARY VELOCITIES BY TRANSVERSE TRAVEL-TIME CURVES OF REFRACTED WAVES. I: Aka Nauk SSSR, Bull., Geophysics Ser., in translation, 1958, no. 12, p. 870-877, 11 figs. incl. diags., graphs, 3 tables, pub. Jan. 1960, 5 refs.

In this study a graphic method of determining boundary velocity is suggested, namely, a determination from 2 traveltime curves of transverse wave corresponding to the same refracting boundary and traveling in the same direction. The procedure of observations along the transverse profile is discussed. The analysis of the accuracy of the suggested method shows that the relative error in the determination of boundary velocity from the profile across the contact does not exceed 5% where the dip is less than 15°. Several examples of the application of the method are given. Comparison of the results with those obtained by the longitudinal profile method shows good agreement. The method also makes it possible in certain cases to take into account discontinuous variations in the boundary velocity along the refracting layer if these variations are not smal er than about 250 m. per sec.--S. T. Vesselowsky (courtesy Geophysical Abstracts 177-341).

2-1183. Karus, E.V., and V.B. Zuckernik. AN ULTRASONIC APPARATUS FOR STUDYING THE PHYSICAL AND MECHANICAL PROPERTIES OF ROCKS INTERSECTED BY A DRILL-HOLE: Akad. Nauk SSSR, Bull., Geophysics Ser., in translation, 1958, no. 11, p. 755-761, 12 figs. incl. 4 diags., graph, pub. Dec. 1959, 20 refs.

This article describes a model of an apparatus for making a detailed ultrasonic pulse logging of dril holes. The working principle of the apparatus is similar to the working principle of ultrasonic defect oscopes and apparatuses for seismic modeling. The authors made tests under laboratory conditions and in a deep hole. They demonstrated that it was possible to make a detailed determination of the velocities of longitudinal and transverse waves in rocks; furthermore, they studied the dynamic peculiarities of elastic waves.--Auth.

2-1184. Kovalev, O.I. LOW FREQUENCY RECEIVER FOR SESMIC [SIC] PROSPECTING: Akad. Nauk SSSR, Bull., Geophysics Ser., in translation, 1958, no. 7, p. 519-522, 8 figs. incl. illus., diags., pub. Nov. 1959, 13 refs.

In recent years low-frequency seismographs have become very popular in surveys of the earth's crust by deep seismic profiling. Seismographs of such type were developed by several Russian geophysicists, but mainly for station use. Kovalev has constructed the first low-frequency seismograph of light weight and sturdy construction convenient for field work along the lines recommended by Jones and Dennison. A description of this instrument (Mark NS-1), with its characteristic curves as well as numerous seismograms taken in the field, are given in the article. Its natural frequency was found to be 5 hours. This is a very sensitive instrument, making it possible to use smaller charges of explosives, while at the same time obtaining clearer records than with other instruments. Eight NS-1 instruments tested during a 2-month survey in the Donets basin maintained their high precision and sensitivity in spite of very great traverses from station to station over very poor dirt roads (total length over 3,000 km.).--S. T. Vesselowsky (courtesy Geophysical Abstracts 176-[illegible]32).

2-1185. Galperin, E.I., and I.P. Kosminskaya. CHARACTERISTICS OF THE METHOD OF DEEP SEISMIC SOUNDING ON THE SEA: Akad. Nauk SSSR, Bull., Geophysics Ser., in translation, 1958, no. 7, p. 475-483, 9 figs. incl. map, diags., graphs, pub. Nov. 1959, 15 refs.

Galperin and Kosminskaya describe the application of the method of deep seismic profiling to sea-bottom surveys, based on experiences in the central Caspian Sea. Different procedures were employed. Nine different combinations were tried of fixed and movable shot points; continuous, interrupted, or point profiling; and single or multiple recording points. The movable shot point combined with point recording is recommended. Low-frequency shot points gave much better results. A combination of littoral and underwater explosions is also recommended. Profiles can be as long as 200 to 250 km. from the shot point to the last hydrophone. The study of the sea bottom can be substantially enriched by observations and recordings of weak local earthquakes at stations on the shore, giving information on layer velocities and on local crustal structure, especially on the location of seismically active layers.--S. T. Vesselowsky (courtesy Geophysical Abstracts 176-341).

2-1186. Rosenfeld, Arthur H. DETECTION OF BOMB TESTS (In: Fowler, John M., ed. Fallout, a Study of Superbombs, Strontium 90 and Survival: p. 136-154, 2 charts, seismograph, table, New York, Basic Books, 1960) refs.

Before agreement can be reached on cessation of nuclear tests, a practical system must be devised for detecting and identifying nuclear explosions; this was the conclusion reached at the Geneva conference of experts in 1958. The size of nuclear explosions to date has ranged from somewhat less than a kiloton to over 2 megaton equivalents of TNT. They may be exploded on the surface, underground, or in outer space. Surface testing is easily detected and the problem of detecting explosions in outer space is not an immediate problem, the feasibility of such tests being several years away. The first U. S. underground test was the 1.7-kiloton "Rainier" explosion held 900 ft. below a mesa surface in the Nevada Proving Grounds, Sept. 1957. This and subsequent underground explosions indicate that they are relatively easy to mask but that the most promising means of detection lies in seismic detection methods. The key to distinguishing earthquake shocks from nuclear explosions lies in the fact that earthquakes result from slow shearing of rock whereas nuclear shocks are sudden, compressional, and radiate shock waves nearly equally in all directions. Seismic stations set up to detect for nuclear explosions would have to be spaced carefully to ensure against using natural earthquakes to hide deliberate testing.--M. Russell.

2-1187. Gzovsky, M.V., V.N. Krestnikov, I.L. Nersessov, and G.I. Reisner. A COMPARISON OF TECTONICS AND SEISMICITY IN THE GARM REGION, TADZHIK SSR. II: Akad. Nauk, SSSR, Bull., Geophysics Ser., in translation, 1958, no. 12, p. 829-839, 8 figs. incl. 4 maps, diags., graphs, 3 tables, pub. Jan. 1960, 28 refs.

Seismicity and tectonics of the Garm region were compared by new methods which represent an attempt of consistent application of certain physically substantiated principles of simultaneous seismic and tectonic analysis on a concrete example. The fundamental characteristic of such comparison lies in the fact that for the first time results of tectonic analysis are expressed quantitatively, though in a rather approximate way. It is of importance that epicenter maps were combined not only with the usual tectonic maps but also with a special map showing present structure and ancient history of the region as well as the distribution of the velocity of Quaternary movements.

The comparison proved that the areas with increased seismic activity within the Garm region coincide with belts where the mean velocity gradient of Quaternary tectonic movements is increased also. The seismic activity increases if the mean velocity gradient is higher. If this is corroberated by other seismoactive regions, it might be possible to develop a method for outlining zones of various seismic conditions from short-term (2 to 3 years) observations of weak earthquakes and from the velocity gradient of present tectonic movements.

It might perhaps be necessary during seismic interpretation of the mean velocity gradient of tectonic movements to apply substantial corrections based on data concerning deep structure, history and type of deformation of the crust, and the size of faults in the investigated regions.--Auth. concl.

2-1188. Zhao, Juzhang (Chao, Chüchang). METEOROLOGY AND SEISMOLOGY IN CHINA. Translated from Priroda, 1959, 10, 27-34, by E.R. Hope: Canada, Directorate Sci. Inf. Service, Defence Research Board, [Translation] T 334 R, 8 p., map, 6 diags., Dec. 1959.

Recent research carried out by the Institute of Geophysics, Academy of Sciences of the Chinese

People's Republic (Peking) in atmospheric circulation, long-term weather forecasting, and seismology are summarized. The Tibetan plateau is found not to be related to the existence of jet streams in the area but it does have a braking effect on the E.-moving cyclonic storms. A "Catalogue of Chinese Earthquakes" lists 1,180 major shocks from 1189 B.C. to 1955 A.D. and includes advice on construction problems organized by districts. Research and development of seismic-recording instruments emphasizes simplicity of design and operation, ruggedness, and portability.--M. Russell.

2-1189. Bulashevich, Yu. P. METHOD OF DETERMINING THE EMANATION COEFFICIENT OF ROCKS IN THEIR NATURAL OCCURRENCE: Akad. Nauk SSSR, Bull., Geophysics Ser., in translation, 1958, no. 11, p. 797-800, diag., 3 tables, pub. Dec. 1959, 11 refs.

Measurements of the concentration of emanation and gamma intensity permit the determination of the relative emanation coefficient under conditions of natural occurrence of rocks, i.e., the finding of the ratio of the emanation coefficient to the porosity. For inhomogeneous distribution of radioactive elements and insufficient correlation between the spatial distribution of the concentration of emanation and gamma intensity, the relative emanation coefficient is determined by the mean value of the measured quantities.

Observations show that the relative emanation coefficient is a stable parameter, which is characteristic of specific rock differences. The determination of the relative emanation coefficient for radon of biotite granitic gneisses, graphite-coal-siliceous slates and disintegrated granitic gneisses in the zone of exocontact of granite intrusive gave the following values: 0.24, 3.4, and 1.8 - 2.1. For air porosity of naturally humid ground of the order of 20%, the emanation coefficient is correspondingly estimated at 5, 70, and 40%. The emanation coefficient for thoron in all cases was of the order of 5%.

Knowledge of the relative emanation coefficient permits a precise classification of emanation anomalies and the differentiation of anomalies of content, emanation, and gaseous corona. The anomalously large emanation established for certain graphitized rocks makes possible their mapping, prospecting of shallow beds of graphite, and also the nonmetallic electroprospecting anomalies in searches for beds of sulfides in the zone of development of graphite slates possessing elevated conductivity. Moreover, an estimate of the emanation in natural occurrence of rocks gives additional information on the substances, mineral carriers of activity, since the high emanation is usually characteristic for finely dispersed, colloidal forms of occurrence of radioactive formation.--Auth. concl.

2-1190. Iokhelson, S.V. THE EMISSION OF RADON FROM ROCKS AT HIGH TEMPERATURES: Akad. Nauk SSSR, Bull., Geophysics Ser., in translation, 1958, no. 12, p. 845-847, 3 diags., table, pub. Jan. 1960, 2 refs.

All rocks emanate a certain amount of Rn, which as an inert gas occupies voids and capillaries in rocks and spaces in crystal lattices of minerals. The coefficient of Rn emanation of a rock, defined by the formula:

$$K_{Rn} = \frac{q_n - q}{q_n} \cdot 100\%$$

(where q_n and q = amounts of Rn before and after heating, respectively), was investigated experimentally by measuring the gamma radiation of various samples before and after heating at different temperatures with time constant, or at constant temperatur for different periods of time. The rock types investigated were silicates, hematite-magnetite rocks, carbonates, and caustobioliths.

The curves of Rn emanation as a function of temperature show that K_{Rn} depends on the composition of the rock and on the thermal properties of the essential rock-forming minerals. Crystalline rocks composed of minerals which do not disintegrate upon heating show a sharp increase in K_{Rn} at a temperature corresponding to the beginning of destruction of the crystal lattice (about 700°C). The intense liberation of Rn by carbonates is caused by their dissociation. Caustobioliths give up the largest part of their Rn at low heats. Complete liberation of Rn takes place at temperatures exceeding the melting temperature (1,700°C. to 1,800°C.), after 5 minutes. If the duration of heating (constant temperature) is increased, the coefficient K_{Rn} increases to a certain limiting value characteristic for each temperature; with increased temperature the time necessary for complete liberation of Rn decreases. With repeated heating of heat-resistant rocks, the emanation coefficient remains practically unchanged.

These results should be of interest in explaining the kinetics of processes in the earth's crust, in age determinations, in interpreting emanation survey results, and in radiometric analysis of rocks.--S. T. Vesselowsky (courtesy Geophysical Abstracts 177-316).

2-1191. Kolesnikov, A.G., and A.A. Speranskaya. A DEVICE FOR DETERMINING HEAT-FLOWS: Akad. Nauk SSSR, Bull., Geophysics Ser., in translation, 1958, no. 11, p. 781-785, 8 figs. incl. illus., 6 diags., pub. Dec. 1959, ref.

Single measurements as well as continuous recordings of heat flows within snow and ice covers in soil, and through the bottoms of water storage reservoirs performed with the help of a thermogage, show that the proposed method is characterized by a high accuracy and simplicity. It has the further advantage that it allows the study of heat exchange processes under natural conditions without the necessity of taking samples.--Auth. concl.

2-1192. Zharkov, V.N. ON THE THERMAL CONDUCTIVITY COEFFICIENT OF THE EARTH'S MANTLE: Akad. Nauk SSSR, Bull., Geophysics Ser., in translation, 1958, no. 11, p. 776-780, 5 diags., table, pub. Dec. 1959, 17 refs.

A detailed study of the thermal conductivity coefficient of the earth's mantle was made. This coefficient is composed of 2 parts: the crystal-lattice component attributable to the usual mechanism of thermal conductivity in crystals, i.e., the diffusion of the thermal excitations of phonons, and of the radiation component related to the transfer of heat by infrared electromagnetic vibrations.

A formula was derived for the crystal-lattice part of the thermal conductivity coefficient, which denotes the coefficient's dependence on temperature and pressure. The article shows the computation of the radiation part of the thermal conductivity coefficient developed on the basis of the kinetic theory of gases. The study indicates the qualitative correctness of Slichter's hypothesis of the cooling of the earth.--Auth.

2-1193. Drake, Charles L., Maurice Ewing, and George H. Sutton. CONTINENTAL MARGINS AND GEOSYNCLINES: THE EAST COAST OF NORTH AMERICA NORTH OF CAPE HATTERAS (In: Ahrens, L.H. and others, eds. Physics and Chemistry of the Earth. [V.] 3: p. 110-198, 10 maps (4 fold.), 15 secs. (8 fold.), 18 diags., New York, Pergamon Press, 1959) approx. 175 refs.

Many geophysical measurements, including seismic refraction, gravity, magnetics, and echo soundings, have been made along the continental margin of eastern North America N. of Cape Hatteras in the last 20 years. These have revealed the presence of 2 sedimentary troughs, one under the shelf, the other in deeper water under the continental slope and rise which are separated by a ridge in the basement near the edge of the shelf. The sediments in the shelf trough have been drilled to a depth of 10,000 ft. and are of shallow water character. Cores of the upper part of the sediments of the outer trough have revealed features attributed to slumping, sliding, and turbidity current action, and, in part, sediments similar to the graywackes of Pettijohn's classification.

This sedimentary system is quite comparable to the Appalachian system as restored for early Paleozoic time. The sediments of the inner and outer troughs are similar to those of the Appalachian miogeosyncline and eugeosyncline respectively, and the basement ridge resembles the Precambrian axis which separates these 2 troughs in the Appalachians. While there is no active volcanism in the outer (eugeosynclinal) trough at the present time, evidence of the past volcanism is present in the form of partially buried seamounts with large magnetic anomalies. Conditions in the Appalachian eugeosyncline appear to have been similar with but limited volcanism prior to the beginnings of Taconic activity.

The gravity calculations reveal an abrupt change in depth of the Mohorovičić discontinuity near the edge of the shelf. There is some indication that the boundary between the crust and the mantle in this area is gradational rather than a sharp discontinuity.

The major process necessary to convert the present continental margin into a mountain system is the one which thickens the crust under the outer, or eugeosynclinal trough. Since the miogeosyncline is already based on a crust of continental proportions, its deformation requires only a means of folding and thrusting the surficial sediments. This is but a minor part of the over-all tectonic activity.--Auth.

2-1194. Officer, Charles B., J.I. Ewing, J.F. Hennion, D.G. Harkrider, and D.E. Miller. GEOPHYSICAL INVESTIGATIONS IN THE EASTERN CARIBBEAN: SUMMARY OF 1955 AND 1956 CRUISES (In: Ahrens, L.H., and others, eds. Physics and Chemistry of the Earth. [V.] 3: p. 17-109, 2 maps (1 fold.), 6 secs. (2 fold.), 77 profiles, 9 diags., fold. seismograph, table, New York, Pergamon Press, 1959) 38 refs.

This paper is concerned with an intensive examination of an island arc and deep sea trench and its associated interior basin. The area investigated was between 10°-25°N. and 53°-70°W. The 1955 work was conducted from the research vessels Atlantis and Caryn and the 1956 work from the research vessels Atlantis and Bear.

The instrumentation for these cruises was much the same as that for other marine seismic refraction cruises. Both cruise ships, in this investigation, were equipped to record and shoot. Both vessels made frequent bathythermograph lowerings to provide a record of ocean temperature vs. depth from the ocean surface down to a depth of 900 ft.; this information was used to compute the velocity of propagation of the direct water wave.

Except for the Cayman trough in the northwestern part, the deepest water found inside the island arc of the Caribbean is in the Venezuelan basin. In some places the depth exceeds 2,500 fathoms and in others the depth is greater than 2,900 fathoms.

The average oceanic structure is 5 km. of water, 1 km. of low-velocity sediments, and 5 km. of crustal rocks (velocity about 6.5 km./sec.) overlying the mantle (velocity about 1.8 km./sec.). The crustal structure in the deepest part was found to be similar to the oceanic structure with significant differences. The high-velocity crustal rock is not included in a single layer with the same velocity throughout, but is so constituted that the lower part has a higher velocity than the upper part. The crustal materials are thicker in general than the normal oceanic crust and thicken appreciably out from the central portion of the basin. The lower velocity materials (1.7-5.5 km./sec.) overlying the crust are thicker than in the Atlantic basin.

The authors suggest that the entire area has been extensively intruded by a differentiate migrating upward from deep in the mantle, and that the raised portions were the areas where most of the material reached the surface. The deep sea trench resulted from the expanded Caribbean crust having been overthrust onto the oceanic crust. This overthrust depressed the high-velocity layers on the oceanic side of the arc creating the deep sea trench and the associated negative anomaly belt.--T. F. Rafter, Jr.

2-1195. Koryakin, E. D. ON THE DEEP STRUCTURE OF THE EARTH'S CRUST WITHIN THE CONFINES OF THE ATLANTIC OCEAN: Akad. Nauk SSSR, Bull., Geophysics Ser., in translation, 1958, no. 12, p. 860-865, 2 maps, 6 profiles, pub. Jan. 1960, 11 refs.

This is a review of the work of geophysicists, mostly American and British, who have been studying the crust under the Atlantic Ocean and its seismological characteristics.--S. T. Vesselowsky (courtesy Geophysical Abstracts 176-233).

7. GEOCHEMISTRY

See also: Stratigraphy 2-1134, 2-1144; Geophysics 2-1163; Mineral Deposits 2-1244, 2-1247, 2-1249, 2-1252; Fuels 2-1287.

2-1196. Tomkeieff, S.I. GEOCHEMISTRY IN THE U.S.S.R. (1954-1956) (In: Ahrens, L.H., and others, eds. Physics and Chemistry of the Earth. [V.] 3: p. 349-413, New York, Pergamon Press, 1959) approx. 1,200 refs.

A literature survey of the progress of geochemistry in the U. S. S. R. during the 3-year period. A previous review published in Physics and Chemistry of the Earth, v. 1, covered the 6 years, 1948-1953, and produced a bibliography of about 700 items, compared with the more than 1,200 titles in the present paper. The increase is due to more extensive coverage of the field of publication, to the inclusion of a restricted number of works published prior to 1954, but primarily to the great increase in the amount of work done in this field. As in the previous review, only highlights are mentioned. The term "geochemistry" has been interpreted to include all fringes of the science, including chemical and structural mineralogy, petrology, sciences of ore deposits, pedology, volcanology, oceanography, limnology, and cosmochemistry as represented by the meteorites. The paper covers geochemistry as developed in the U. S. S. R. through the medium of the principal publications only; many books and periodicals are not available.--From auth. introd.

The review is divided into 6 sections: 1) geochemistry, geospheres, elements; 2) minerals; 3) mineral deposits; 4) igneous and metamorphic rocks; 5) sedimentary rocks; 6) natural waters and evaporates.

2-1197. Belov, N.V., and V.I. Lebedev. **SOURCES OF ENERGY IN GEOCHEMICAL PROCESSES. Translated by Danute E. and Mathew N. Nitecki: Internat. Geology Rev., v. 2, no. 1, p. 43-51, 4 diags., Jan. 1960, 16 refs.**

Large sources of energy are required to account for all known past and continuing geological processes. Exogenic forces are fed by solar energy, but the source of endogenic forces are not so clearly understood. Earlier theories to account for such energy, such as residual heat from an originally molten earth and accumulation of heat from radioactive minerals, are in conflict with known facts. A basic difference exists between the lattice structure of magmatic and high-grade metamorphic rocks on the one hand and sedimentary and low-grade metamorphic rocks on the other; in the former the basic lattice structure is 1 Al atom and 4 O atoms in tetrahedral form, in the latter it is 1 Al atom and 6 O atoms in octahedral form. Similar distinctions are noted for other elemental associations. The bonding properties of Al and Si in the former class of rocks are covalent; in the latter one finds the bonds between Al and O to be ionic and between S and O, half ionic. This indicates that the 2 groups represent different energy states, and that minerals of the first group store energy which is released in being converted to minerals of the second group. In the formation of minerals in the zone of weathering there is an increase in interatomic distances which results in absorption of energy. It follows then that storage of energy occurs in the formation of minerals of the zone of weathering and that this energy is liberated in the formation of minerals deep in the earth's crust. Examples of known chemical relations and other references to observed phenomena are cited to support this hypothesis.--M. Russell.

2-1198. Adams, C.E., N.H. Farlow, and W.R. Schell. **THE COMPOSITIONS, STRUCTURES AND ORIGINS OF RADIOACTIVE FALL-OUT PARTICLES: Geochim. et Cosmochim. Acta, v. 18, no. 1/2, p. 42-56, 11 illus., graph, Jan. 1960, 4 refs.**

The chemical compositions, structures, and modes of origin of several different types of radioactive fall-out particles have been determined through petrographic techniques, X-ray diffraction analysis, radioautography, and specially prepared reagent films for liquid fall-out. The fall-out particles studied were collected following the detonation of nuclear weapons under various conditions at both the Nevada Test Site and the Eniwetok Proving Grounds. Radioactive fall-out particles were formed by the interaction of the condensing vaporized metals and fission products derived from the bomb and associated structures with the surface material swept up into the cooling fireball. Descriptions of the various types of fall-out particles are given and their modes of origin are qualitatively related by a simplified thermodynamic treatment.--Auth.

2-1199. Notz, K.J., and H.H. Jaffe. **CORRELATION OF TGA AND DTA TEMPERATURES IN DECOMPOSITION REACTIONS: Am. Ceramic Soc., Jour., v. 43, no. 1, p. 53-54, Jan. 1960, 3 refs.**

Results of DTA (differential thermal) and TGA (thermogravimetric) analyses may not be directly comparable if a gas phase is involved. TGA results obtained in an atmosphere having a composition close to that furnished by the reaction, yield data closely comparable to DTA. The thermal decomposition of UO_2SO_4 in DTA and TGA apparatus is given as an example.--F. P. Glasser.

2-1200. Roedder, Edwin. **SILICATE MELT SYSTEMS (In: Ahrens, L.H., and others, eds. Physics and Chemistry of the Earth. [V.] 3: p. 224-297, 59 diags., 3 tables, New York, Pergamon Press, 1959) 155 refs.**

A review of the silicate phase equilibrium research to aid in the understanding of igneous rocks, and the study of slags, refractories, and cements. The systems described have many applications to problems in igneous petrology, and with the addition of volatiles under pressure, or pressure alone, may be extended to cover the conditions of formation of most igneous and many metamorphic rocks in the earth's crust.

In addition to a detailed discussion of equilibrium diagrams of the silica melt systems, the author discusses the 5 steps in the determination of a phase diagram of a silicate system by the "quenching" method. These steps: 1) synthesis, the weighing out of appropriate amounts of materials to make the desired composition; 2) homogenization, the conversion of the weighed materials to a homogeneous glass; 3) equilibration, to maintain a constant temperature long enough to obtain equilibrium; 4) quenching, to bring the sample from the high temperature at which it was equilibrated down to room temperature at such a rate that phase changes do not occur; 5) identification, identification of the phases present and the determination of their composition.--T. F. Rafter, Jr.

2-1201. Crowley, M.S., and Rustum Roy. **THE EFFECT OF FORMATION PRESSURES ON SHEET STRUCTURES - A POSSIBLE CASE OF Al-Si ORDERING: Geochim. et Cosmochim. Acta, v. 18, no. 1/2, p. 94-100, 3 diags., table, Jan. 1960, 10 refs.**

Experimental evidence is presented to show that a real change in the b and c dimensions of the unit cell of muscovite occurs as a function of the pressure at which it is synthesized. The contraction caused by changes of pressure from 5,000 to 50,000 lb./in.^{2} is in the range from 0.1 to 0.5%. The effect is demonstrated as being independent of "leaching," hydronium substitution, starting materials, etc. Phlogopite and pyrophyllite do not show the same effect. Chlorite solid solutions with composition near clinochlore show a similar though smaller effect.

The explanation offered for this phenomenon is the progressive ordering of Al-Si at higher pressures. Ordering appears to be enhanced (or made possible) by the presence of a vacancy or substitutional defect in the octahedral layer.--Auth.

2-1202. Zen, E-An. CARBONATE EQUILIBRIA IN THE OPEN OCEAN AND THEIR BEARING ON THE INTERPRETATION OF ANCIENT CARBONATE ROCKS: Geochim. et Cosmochim. Acta, v. 18, no. 1/2, p. 57-71, 3 diags., Jan. 1960, 44 refs.

A model of steady-state equilibrium deposition of carbonates in the open sea, where exchange of material between the sediment and the water is permitted, is studied from the phase-equilibrium point of view. Allowing for the possibility of arbitrary variations in temperature, pressure, and activity of CO_2 in the system, in general only one-carbonate deposits, either calcite or dolomite, should result. The contact between calcite beds and dolomite beds should be sharp although the 2 carbonates should be in mutual equilibrium. Changes in hydrographic conditions may result in onlap-offlap relations in the deposits and apparent interbedding of the strata.

Experimental results in the literature on the solubility of dolomite in water are not all internally consistent, although they do indicate that, under atmospheric conditions, the solution relations are sensitive to the value of the CO_2 activity. Increases in total pressure (depth) favor the precipitation of dolomite. Available thermochemical data indicate that dolomite may be the carbonate phase in equilibrium with many sea-water compositions.

Modern carbonate deposits are either calcite or aragonite at the surface, but may change over, abruptly, to dolomite at depth. Two-carbonate deposits, where carefully studied, show evidence of incomplete reaction. The prevalence of one-carbonate deposits thus accord with theoretical considerations although the nature of the surface deposit is at variance with thermochemical data. In the sedimentary record, carbonate rocks with nearly equal amounts of calcite and dolomite are not uncommon; these beds cannot be due to direct chemical precipitation in the open sea.--Auth.

2-1203. Feodotev, K.M., and V.K. Shlepov. SOLUBILITY OF SALTS OF SOME ELEMENTS IN SUPERCRITICAL WATER VAPOR. Translated by Michael Fleischer: Internat. Geology Rev., v. 2, no. 2, p. 114-119, 2 illus., 2 diags., 2 tables, Feb. 1960, 15 refs.

The intermediate and unstable stages of hydrothermal and pneumatolytic processes are little understood; they have been studied indirectly through research on solubility of salts of certain metals in supercritical water vapor. It has proved very difficult to devise apparatus that can withstand experimental conditions requiring high temperatures and pressures and which will permit separation of the gaseous phase for measurement of its dissolved-salt content. The authors describe an autoclave of their design which they have used to investigate solubilities of certain metal salts at temperatures as high as 430°C. and pressures of 375 atm. Pressure is produced in the autoclave by heating water vapor to the required temperature. The autoclave, whose total volume is 19.5 $cm.^3$, consists of 2 chambers connected by a narrow channel; a needle valve can be operated by external control mechanism to block the channel, separating the 2 chambers. Thus, supercritical vapor can be isolated in 1 chamber before it is cooled and condensed. Cooling and condensation can be brought about independently in either chamber, so that the experiment can be carried to its conclusion within the autoclave. Gaskets usually are made of nonferrous metals and as such are a possible source of contamination to experimental materials; however, through precision grinding of contact surfaces, the need for gaskets was eliminated. The first experiments were made on alkali-chloride solutions to determine chemical analysis methods. Experimental criteria was based on comparison of the initial volume of solution to the final volume of solution in each of the 2 chambers and on the ratios of 2 final volumes to the volumes of the 2 chambers. Alkali-chloride saturation of supercritical solution was approximately 0.5 g. per l.; degree of saturation was found to have only slight dependence on concentration of the original solution. Pb-chloride solubility in supercritical solution, derived from preliminary data, was approximately 2.0 g. per l. These studies indicate that some heavy-metal salts, as well as the lighter alkali salts, can migrate in gaseous solution at pressures found at considerable depths. The resultant solutions are stable in a narrow range of temperatures and pressures; under changing conditions the salts crystallize, liberating water in the process.--D. D. Fisher.

2-1204. Cameron, A.G.W. THE ORIGIN OF THE ELEMENTS (In: Ahrens, L.H., and others, eds. Physics and Chemistry of the Earth. [V.] 3: p. 199-223, 2 charts, 2 diags., 3 graphs, New York, Pergamon Press, 1959) 40 refs.

Past theories on element formation have assumed a uniform chemical composition throughout the universe. Estimates of the cosmic abundances of elements were based on chemical analysis of various constituents of the earth's crust. They failed to consider the loss of volatile constituents from the earth and subjection of the remaining material to extreme chemical differentiation. Chemical and radiochemical analyses of chrondritic meteorites have given abundances of the nonvolatile elements, while spectroscopic analyses of light from stars and gaseous nebulae have been used to estimate the abundance of the volatile elements.

The author, slightly modifying the Suess and Urey curve showing the cosmic abundances of the elements in order to incorporate later solar data, points out that the curve represents only the composition of the solar system, not that of the universe or of the galaxy as a whole. However, a theory of the origin of the elements must explain the individual and general features of the curve.

The neutron capture hypothesis developed by Alpher and Herman fails many detailed tests which involve the relative abundances of several different classes of heavy isotopes, yet survives in its essential features as one of the mechanisms by which heavy elements can be synthesized in stellar interiors. One mechanism by which stars return some of their mass to the interstellar medium is the supernova explosion. The supernova explosion casts off into space, at high velocity, a major portion of the stellar body leaving a white dwarf remnant. Another mechanism is that of the nova explosion in which one part in 1,000 of the stellar mass is thrown off.

The types of nuclear reactions that take place in stellar interiors as temperature and density progressively increase are developed to show that these reactions give products in approximately the proportions required in order to explain the cosmic abundance distribution of the elements.--T. F. Rafter, Jr.

2-1205. Wilson, A.T., and G.J. Fergusson. ORIGIN OF TERRESTRIAL TRITIUM: Geochim. et Cosmochim. Acta, v. 18, no. 3/4, p. 273-277, Feb. 1960, 22 refs.

The possibility of tritium being accreted by the earth from some extraterrestrial source, as has been suggested, has been considered and shown to be highly improbable. The production rate of tritium in the earth's atmosphere by cosmic rays has been calculated from data on the experimentally observed tritium content of meteorites ($0.63^{+0.4}_{-0.2} H^3$ atom/cm.^{2} per sec.), and also from cosmic ray flux data and nuclear evaporation theory ($1.3 \pm 0.5 H^3$ atom/cm.^{2} per sec.). These results are in reasonable agreement with the experimentally determined terrestrial accumulation rate of tritium of $1.0 \pm 0.3 H^3$ atom/cm.^{2} per sec. It thus appears that cosmic ray spallation reactions in the earth's atmosphere are the prime, if not the sole, source of terrestrial tritium.--Auth.

2-1206. Fechtig, H., W. Gentner, and G. Kistner. RÄUMLICHE VERTEILUNG DER EDELGASISOTOPE IM EISENMETEORITEN TREYSA [ABUNDANCE DISTRIBUTION OF RARE GAS ISOTOPES IN IRON METEORITE TREYSA]: Geochim. et Cosmochim. Acta, v. 18, no. 1/2, p. 72-80, 2 illus., diag., table, Jan. 1960, 35 refs.; text in German, abs. in English.

The rare gases He, Ne, and Ar and their isotopic composition were investigated in the Fe meteorite Treysa. The meteorite showed a He^4-content of $\sim 21 \times 10^{-6}$ cm.^{3}/g., an Ar^{36}-content of $\sim 15 \times 10^{-8}$cm.^{3}/g. and a Ne-content of $\sim 6 \times 10^{-8}$ cm.^{3}/g. In dependence of depth the isotopic ratio of Ar^{38}/Ar^{36} and He^4/He^3 varied about 20% in the investigated disk. This variation of the isotopic ratio may be qualitatively explained by the results of spallation investigations on Cu with 0.34 and 2.2 GeV protons and on steel with 0.16, 0.43 and 3.0 GeV protons. Assuming the ratio of the average postatmospheric radius to the average preatmospheric radius of Treysa is 0.44 and the spectrum of the cosmic radiation extends down to 500 MeV, we found by calculation that the variation of the Ar^{38}/Ar^{36}-ratio will be caused only by the primary component. The variation of the He^4/He^3-ratio is presumably a consequence of a secondary radiation. The amount of Ar^{38} found in the disk allowed us to calculate a radiation age of $\sim 10^9$ years. --Auth.

2-1207. Fireman, E.L., and J. DeFelice. ARGON-39 AND TRITIUM IN METEORITES: Geochim. et Cosmochim. Acta, v. 18, no. 3/4, p. 183-192, 4 tables, Feb. 1960, 19 refs.

The radioactive isotopes Ar-39 and tritium are measured in a number of Fe and stone meteorites. The stable isotope He-3 is also measured and the Ar-38 content is estimated from the He-3 content. The cosmic ray exposure ages obtained from the Ar-39 and Ar-38 are: 4.2×10^8 years for the Sikhote-Alin Fe meteorite, 4.5×10^8 years for the Treysa Fe meteorite, 0.3×10^8 years for the Pitts Fe meteorite, 5×10^8 years for the Norton County achondrite, and 0.8×10^8 years for the St. Michel chondrite. The ratio of tritium to Ar-39 radioactivities at the time of fall is 140 ± 20 for the Norton County meteorite, 56 ± 15 for the St. Michel meteorite, 6 ± 1 for the Treysa meteorite, and less than 1/2 for the Sikhote-Alin meteorite. For the stone meteorites this ratio is consistent with the production probabilities and the hypothesis of the constancy of cosmic rays. For the Fe meteorites this is lower than expected from the production probabilities. Either the cosmic ray bombardment is not constant or tritium loss from diffusion occurs for the Fe meteorites.

Also reported is the lack of Ar-39 and tritium in a number of undated Fe meteorite falls, which indicates that they fell more than 1,500 years ago. Only 1 undated Fe meteorite fall, Washington County, gave a small trace of Ar-39, indicating that it fell about 1,000 years ago.

Possible interpretations of the cosmic ray exposure ages are discussed.--Auth.

2-1208. Schindewolf, U., and M. Wahlgren. THE RHODIUM, SILVER AND INDIUM CONTENT OF SOME CHONDRITIC METEORITES: Geochim. et Cosmochim. Acta, v. 18, no. 1/2, p. 36-41, 2 tables, Jan. 1960, 8 refs.

By neutron activation analysis the Rh, Ag, and In content of 5 chondritic meteorites has been determined. The average data are 0.186 and 0.094 p. p. m. for Rh and Ag. The upper limit for the In content is 0.001 p. p. m. The values for Rh and Ag are in fair agreement with the data estimated by Suess and Urey; the In values, however, are lower by a factor of 100 or more.--Auth.

2-1209. Bate, George L., Herbert August Potratz, and John R. Huizenga. SCANDIUM, CHROMIUM AND EUROPIUM IN STONE METEORITES BY SIMULTANEOUS NEUTRON ACTIVATION ANALYSIS: Geochim. et Cosmochim. Acta, v. 18, no. 1/2, p. 101-107, 2 tables, Jan. 1960, 15 refs.

Analyses of 5 chondrites by simultaneous neutron activation yielded average concentrations of $(9.4 \pm 0.3) \times 10^{-6}$ g. Sc/g. meteorite, $(2.2 \pm 0.1) \times 10^{-3}$ g. Cr/g. meteorite and $(7.8 \pm 0.3) \times 10^{-8}$ g. Eu/g. meteorite. Following the assumptions of Urey, these results lead to cosmic abundances of 32, 6,400, and 0.078 (per 10^6 Si atoms) for Sc, Cr, and Eu, respectively. Except for lowering the Eu abundance by a factor of 2, the Suess-Urey abundances based on chondrite analyses are not materially altered. The present results are consistently lower than the solar abundances reported by Aller, approaching nearly an order of magnitude in the case of Eu. The concentrations of the 3 elements in 2 achondrites varied markedly; the Sc/Eu atom ratio, for example, decreased from an average of 410 for the chondrites to 190 for Nuevo Laredo but increased to 5,700 for Johnstown, Colorado.--Auth.

2-1210. Maringer, R.E., and G.K. Manning. AERODYNAMIC HEATING OF THE GRANT METEORITE: Geochim. et Cosmochim. Acta, v. 18, no. 3/4, p. 157-161, illus., 4 diags., Feb. 1960, 4 refs.

The "heat-affected zone" near the surface of the Grant meteorite has been examined by metallographic means. This zone, produced by aerodynamic heating during the fall of the meteorite, serves as a record of the thermal gradient which produced it. By comparison of structure and hardness within this zone with artificially heat-treated meteorite specimens, this thermal gradient was reconstructed. Calculations based on the shape of the thermal gradient have permitted estimates to be made of the rate of heat transfer into the meteorite and of the associated rates of ablation.--Auth.

2-1211. Krinov, E.L. THE TUNGUSKA METEORITE. Translated by Sonia and Brandon Barringer: Internat. Geology Rev., v. 2, no. 1, p. 8-19, 14 illus., 2 maps, graph, seismogram, Jan. 1960, 20 refs.

On June 30, 1908, the Tunguska meteorite fell near the Podkamennaya (Stony) Tunguska river in Evenkysky national district (60°55'N. 100°57'E.), at 11 seconds past 0017 hours Mean Greenwich Time. Eyewitnesses reported a bolide flight from SE. to NW., followed by a violent explosion. Seismic and acoustical phenomena were reported over an area from several hundred to a thousand kilometers radius. Night-sky illumination, occurring throughout the area from mid-June gradually diminishing until its final disappearance in late Aug., was attributed to meteoric dust particles suspended in the atmosphere as a result of the explosion. On the Irkutsk magnetic and weather station seismograph, the impact registered as 2 waves (1.2-m. amplitude) arriving approximately 5 min. apart. Travel time from point of impact to station 893 km. distant, was computed at 45 min., 6 sec., and wave velocity at 330 m. per sec. These and explosion-velocity data have been used in attempts to establish initial (approach) velocity and trajectory of the meteor with respect to earth movement. Investigation of the meteorite fall site began 19 years after the meteorite fell to earth. L. A. Kulik led the first expedition to the fall site in 1927 and subsequent expeditions (undertaken by the U. S. S. R. Academy of Sciences) in 1928, 1929-1930, and 1939. In 1929, a geodetic section directed by S. Ya. Belych established 3 astro-radio points in the area. Aerial photographs were taken of the fall site during the 1929 expedition. Topographic features possibly indicating meteoric impact had been obscured by action of frost, standing water, and Sphagnum moss overgrowth in an area of permanently frozen (permafrost) mud. Phenomena caused by the explosion, e. g. orientation of uprooted trees, were used to locate the fall site during the first expedition. During a subsequent expedition, 2 holes were drilled in a craterlike formation (Suslov crater) on the site. Although no meteorite fragments have been found, an expedition was planned for 1958 to search for fragments at the fall site and to the SE., along the trajectory. Other investigations will include observation and study of topographic effects on shock-wave expansion and more accurate contouring of the area relief.--D. D. Fisher.

2-1212. Adams, John A.S., J. Kenneth Osmond, and John J.W. Rogers. THE GEOCHEMISTRY OF THORIUM AND URANIUM (In: Ahrens, L.H., and others, eds. Physics and Chemistry of the Earth. [V.] 3: p. 298-348, chart, 3 diags., 12 tables, New York, Pergamon Press, 1959) 202 refs.

This paper presents the data and thought regarding the geochemical cycles of Th and U in the common rocks and minerals that make up 99% of the accessible earth. The cosmic abundances of Th and U are based upon : 1) determinations of extraterrestrial material (meteorites) and possible extraterrestrial material (tektites); 2) theoretical considerations involving nuclear stabilities, electronic configurations, and cosmological effects of heat due to radioactivity; 3) determinations on terrestrial rocks.

The distribution of Th and U among the core, mantle, and crust of the earth is discussed by: 1) geochemically classifying these elements as lithophile or oxyphile on the basis of their mineralogy and general chemistry, including valence states, ionic radii, and oxidation potentials; 2) assuming that the earth's crust and mantle were derived from chondritelike material; and 3) interpretations of isotopic analyses of common leads.

The author discusses in detail the distribution and abundance of Th and U in the various igneous rock types, and the behavior of Th and U during magmatic differentiation. Equally detailed is the treatment of Th and U in the sedimentary rock types, the hydrosphere, and atmosphere. However, the lack of sufficient data limit the discussion of metamorphism with respect to Th and U.--T. F. Rafter, Jr.

2-1213. Brooks, R.R., L.H. Ahrens, and S.R. Taylor. THE DETERMINATION OF TRACE ELEMENTS IN SILICATE ROCKS BY A COMBINED SPECTROCHEMICAL-ANION EXCHANGE TECHNIQUE: Geochim. et Cosmochim. Acta, v. 18, no. 3/4, p. 162-175, illus., 3 diags., 4 tables, Feb. 1960, 18 refs.

The paper describes an attempt to combine anionic exchange enrichment techniques with a spectrochemical method of analysis for the purpose of determining several rare elements in silicate rocks, soils, and meteorites. The investigation has for the most part been confined to several elements which form chlorocomplexes in hydrochloric acid; notably Ag, Pb, Sn, Bi, Cd, Zn, Tl, Mo, and In. These may be absorbed on a basic anion exchanger. After elution and evaporation, the residues are analysed quantitatively by a d. c. arc method. The ability to determine several trace elements in a single general operation is an advantage of the procedure.

The combined procedure has been applied to the determination of Cd, Zn, Bi, Tl, and Sn in a suite of 19 rocks including granite G-1 and diabase W-1, and specimens of gneiss and sea-mud from the Antarctic. --Auth.

2-1214. Hamaguchi, Hiroshi, Rokuro Kuroda, and Hideo Ishikawa. THE DISTRIBUTION OF MINOR ELEMENTS IN THE ROCKS OF SAKURA-JIMA VOLCANO: Geochim. et Cosmochim. Acta, v. 18, no. 3/4, p. 232-246, 10 diags., 6 tables, Feb. 1960, 13 refs.

Geochemical and crystallochemical relationships in the lavas and pyroclastics of Sakura-jima volcano, Japan, suggest that magmatic differentiation is the dominant fractionation process. A triangular diagram is shown for Na-K-Ca and total Fe-Mg-Na + K. The volcanics investigated are the Kitadake, Minamidake, unknown eruption epoch, 1468-1476, 1779, 1914, 1946 flows, and 1955-1958 pyroclastics. Trends are illustrated in Cr, Mg, Ca, V, Fe, Si, Al, Ga, and O in modified Larsen diagrams. Various ionic ratios, especially V/Fe, show marked variation on the modified Larsen plot. From the 1468-1476 until the 1914 eruptions, the Sakura-jima lavas tend to become more mafic. From 1946 until 1958, there is a tendency to become more silicic. However, within the 1955-1958 volcanic sequence, Co, Cr, and V increases suggest increasing mafic differentiation of the lavas and pyroclastics. Distinct and extreme anomalies occur in Co, Cr, and V in the initial pulse of a given eruption within the 1955-1958 sequence.

During the initial high energy eruptive phase, expulsion of mafic differentiates (enriched in Co, Cr, and V) consolidated in the volcanic throat is thought to account for these high concentrations. Pb is also enriched in the early eruptive phases in the 1955-1958 volcanic series. Volcanic sublimates accumulating during the inter-eruptive period in the pyroclastic material within the volcano may account for this phenomenon. Spectroscopic analyses for Ga, Ni, Co, Cr, V, Pb, and Sn are given for 62 sanples.--Auth.

2-1215. Vincent, E.A., and J.H. Crocket. STUDIES IN THE GEOCHEMISTRY OF GOLD - I. THE DISTRIBUTION OF GOLD IN ROCKS AND MINERALS OF THE SKAERGAARD INTRUSION, EAST GREENLAND: Geochim. et Cosmochim. Acta, v. 18, no. 1/2, p. 130-142, 2 diags., 3 tables, Jan. 1960, 13 refs.

Au has been determined by neutron activation analysis in a suite of rocks from the strongly differentiated Skaergaard gabbroic complex and in some of the constituent silicate, oxide, and sulfide minerals. The chilled marginal gabbro (taken as representative of the initial magma) contains 0.0046 p.p.m. Au, and with 4 exceptions all rocks and minerals analyzed carry between half and twice this amount. The uncharged Au atom shows no preference for any one of the various silicate, oxide, and iron sulfide minerals, but is very strongly concentrated in the copper sulfides, emphasizing the chemical similarity of the Cu and Au atoms rather than any general chalcophile tendency on the part of Au.--Auth.

2-1216. Vincent, E.A., and J.H. Crocket. STUDIES IN THE GEOCHEMISTRY OF GOLD - II. THE GOLD CONTENT OF SOME BASIC AND ULTRABASIC ROCKS AND STONE METEORITES: Geochim. et Cosmochim. Acta, v. 18, no. 1/2, p. 143-148, 5 tables, Jan. 1960, 11 refs.

Analyses by the neutron activation method reveal about 0.002 p. p. m. Au in 2 basalts from the British Tertiary igneous province and in 1 Recent Hawaiian flow. From 0. 001 to 0. 01 p. p. m. Au has been found in dunites and olivine-rich nodules included in basalts, the majority of results being appreciably higher than for the basalts analysed. Four chondritic meteorites carry from 0. 1 to 0. 3 p. p. m. Au, which appears most probably to be concentrated in the dispersed metallic phase.--Auth.

2-1217. Wedepohl, K.H. SPURENANALYTISCHE UNTERSUCHUNGEN AN TIEFSEETONEN AUS DEM ATLANTIK. EIN BEITRAG ZUR DEUTUNG DER GEOCHEMISCHEN SONDERSTELLUNG VON PELAGISCHEN TONEN [TRACE ELEMENT INVESTIGATION OF DEEP-SEA CLAYS IN THE ATLANTIC. A CONTRIBUTION TO THE INTERPRETATION OF THE GEOCHEMICAL SIGNIFICANCE OF PELAGIC CLAYS]: Geochim. et Cosmochim. Acta, v. 18, no. 3/4, p. 200-231, map, diag., 7 tables, Feb. 1960, 93 refs.; text in German, abs. in English.

The data from these minor element investigations of Atlantic bottom samples shall contribute to a geochemical comparison of pelitic sediments from different oceans. General considerations about the source of abnormally high abundances of some elements in pelagic clays in comparison with nearshore argillaceous sediments should depend on representative data of best quality. Therefore only methods of X-ray fluorescence, d. c.-arc spectroscopy, and colorimetry with less or about 10% standard deviation have been applied for this investigation.

Eighteen samples and 2 composites (with no or moderate carbonate content) have been analyzed for the following minor elements: Sc, Ti, V, Cr, Mn, Co, Ni, Cu, Zn, Ga, Rb, Sr, Y, Zr, Mo, Ba, La, Pb. Data of the same elements in nearshore clays and shales have been revised and supplemented. Some analyses of Pacific samples could be checked.

The main result of this investigation is the grouping of elements into 3 classes with different geochemical behavior:

a) The average abundances of Ti, V, Cr, Ga, Rb, and Zr are the same in nearshore and pelagic clays within the limits of analytical error.

b) On the average the elements La, Sc, Y, and Ba are as abundant in nearshore clays as in pelagic clays from the Atlantic but are more abundant in those from the Pacific.

c) The average abundances of Zn, Ni, Pb, Cu, Co, Mn, and Mo increase from nearshore argillites to Atlantic clays and from there to Pacific clays regardless of similar composition in their major elements.

The fact that elements like Ti, V, Cr are not enriched in these clays shows that there is no enhanced contribution from submarine weathering of volcanics and pyroclastics.

For the discussion of higher abundances of Group B elements in Pacific clays one should consider the evidence of organic contributions to the sediment and mobilization during diagenesis.

The abundances of the Group C elements in clays from the 2 oceans exceeding that of nearshore argillites are presented in a diagram. It shows a striking proportionality between the sediments from the Atlantic and the Pacific in relation to the abundances of these elements. This should be interpreted as the result of 1 uniform process. Most of these elements exceed the values required for balance computations of weathered average crust material, if the portion of pelagic clays in all the sediments is estimated as 10%. This figure of 10% is supported as a minimum by geological and geophysical experience. Extraterrestrial sources cannot supply the abovementioned element association in the abundances established. However, this association seems to be typical for volcanic exhalations. An influence of the secular air-contaminating action of these emanations on sediments with a rate of sedimentation in the range of mm. per thousand years must be taken in account according to thermodynamical and geological evidence.

The proportion 1:3·4 in the diagram probably reflects the different average rates of sedimentation in the 2 oceans.--Auth.

2-1218. Yamagata, Noboru, Yukio Murakami, and Tetsuya Torii. BIOGEOCHEMICAL INVESTIGATION IN SERPENTINE-CHROMITE ORE DISTRICT: Geochim. et Cosmochim. Acta, v. 18, no. 1/2, p. 23-35, 2 maps, 9 diags., 6 tables, Jan. 1960, 23 refs.

Chemical analyses were made of stream and underground waters, soils, and vegetation from a serpentine-chromite ore district [Hinokami mining district, Japan]. The distribution of several elements in plant and soil was examined statistically, and soil-plant relationships were discussed. Of 18 species of plant examined, Clethra and Castanea showed great accumulation of Co and Mn, respectively. Lognormal distribution was assumed in plant for several elements.--Auth.

2-1219. Merrill, J.R., E.F.X. Lyden, Masatake Honda, and James R. Arnold. THE SEDIMENTARY GEOCHEMISTRY OF THE BERYLLIUM ISOTOPES: Geochim. et Cosmochim. Acta, v. 18, no. 1/2, p. 108-129, diag., 18 tables, Jan. 1960, 24 refs.

The sedimentary geochemistry of Be has been investigated with a view toward the use of cosmic-ray-produced Be^{10} for geochronology. Analyses of some Pacific ocean water samples give an average total Be content of 6×10^{-13} parts per part (p.p.p.), less than half of which is retained by a Millipore filter. The concentration of Be^9 in 5 deep ocean sediment cores ranges from 2 to 3 p.p.m. These data indicate an ocean residence time for Be of the order of a few hundred years. Analyses of river water give concentrations of about 10^{-10} p.p.p., substantiating this residence time. An abrupt change in Be^{10} content with depth in a Pacific sediment core correlates with a change in the ionium-Th ratio reported by Goldberg and Koide for the same core.--Auth.

2-1220. Tudge, A.P. A METHOD OF ANALYSIS OF OXYGEN ISOTOPES IN ORTHOPHOSPHATE - ITS USE IN THE MEASUREMENT OF PALEOTEMPERATURES: Geochim. et Cosmochim. Acta, v. 18, no. 1/2, p. 81-93, 2 diags., 3 tables, Jan. 1960, 25 refs.

An analytical procedure is presented for the determination of the O^{18}/O^{16} ratio in orthophosphate and condensed phosphate. In the described procedure the phosphate is first purified and then finally precipitated as $BiPO_4$. The phosphate O is released by the following reaction; then it is purified and analysed mass spectrometrically:

$$BiPO_{4(s)} + 8/3\, BrF_{3(l)} \rightarrow$$
$$BiF_{3(s)} + PF_{5(g)} + 4/3\, Br_{2(g)} + 2\, O_{2(g)}$$

The method is quantitative, free from isotopic fractionation and exchange, and precise to ± 0.15 ‰. A correction can be made for the contaminating effect of water O introduced during the hydrolysis of the condensed phosphates.

The possibilities are given for the use of this procedure in the measurement of paleotemperatures.--Auth.

2-1221. Compston, W. THE CARBON ISOTOPIC COMPOSITIONS OF CERTAIN MARINE INVERTEBRATES AND COALS FROM THE AUSTRALIAN PERMIAN: Geochim. et Cosmochim. Acta, v. 18, no. 1/2, p. 1-22, 3 illus., map, chart, 7 graphs, 9 tables, Jan. 1960, 20 refs.

δC^{13} analyses are reported for Permian and Devonian brachiopods, Permian crinoids, and Permian coals. δO^{18} analyses of the marine invertebrates are also given. Only the Permian brachiopods are isotopically preserved. Their mean δC^{13} value is significantly more positive than Cretaceous and Recent brachiopods and molluscs measured elsewhere. A single coal seam sampled in detail was very constant in δC^{13}, and a trend towards values some 2.5 ‰ more negative from lower to upper Permian was observed for a sequence of seams. The lower Permian coal δC^{13} was approximately the same as upper Carboniferous coal measured elsewhere. The meaning of this Permian isotopic distribution is discussed in terms of an age-effect, but there are other possible explanations.--Auth.

2-1222. Lal, Devendra, Edward D. Goldberg, and Minoru Koide. COSMIC-RAY-PRODUCED SILICON-32 IN NATURE: Science, v. 131, no. 3397, p. 332-337, diag., 2 graphs, table, Feb. 5, 1960, approx. 16 refs.

This article concerns itself with the isotope Si^{32} as it occurs in nature, particularly as it is found in the marine hydrosphere and its inhabitants. Primary concern is its application as a tracer in ocean water circulation and in indicating the removal of Si from sea water by biological activity. Three sample sponges were taken from the Gulf of California, and, after the removal of the Si by chemical means, the radioactive disintegration was measured at 19.6 ± 1.3 per minute per gram of Si. Assuming the 2-layer model proposed by Craig, the authors computed the average mixing time for the 2 layers as more than 1,500 years.--B. C. Schreiber.

2-1223. Krejci-Graf, Karl, and Frans E. Wickman. EIN GEOCHEMISCHES PROFIL DURCH DEN LIAS ALPHA (ZUR FRAGE DER ENTSTEHUNG DES ERDÖLS) [A GEOCHEMICAL PROFILE THROUGH THE LIAS ALPHA (ON THE QUESTION OF THE ORIGIN OF PETROLEUM)]: Geochim. et Cosmochim. Acta, v. 18, no. 3/4, p. 259-272, 10 tables, Feb. 1960, 29 refs.; text in German, abs. in English.

A systematic study of trace elements and isotopes in lithological profiles and connected oils might lead to the determination of source rocks. This paper is a first attempt in this line; results will be conclusive only after a study of the whole stratigraphic sequence has been completed.

There is practically no difference between the ratio $C^{12}:C^{13}$ in bituminous shales and oils from the Lias alpha. It seems that during bituminization and oil-forming the ratio is changed as little as in the forming of coals. No connection was found between degree of salinity of sedimentational environment, and $C^{12}:C^{13}$ ratio of oils present in such sediments. Of trace metals, oils contain notably less Cr than the shales of their vicinity; the same relationship is observed between tars ("oils") and their parent oil shales.--Auth.

2-1224. Lemmleyn, G.G., and M.O. Kliya. DISTINCTIVE FEATURES OF THE HEALING OF A CRACK IN A CRYSTAL UNDER CONDITIONS OF DECLINING TEMPERATURE. Translated by V.L. Skitsky: Internat. Geology Rev., v. 2, no. 2, p. 125-128, 4 illus., Feb. 1960, 3 refs.

The ratio by volume of liquid to gaseous phases entrapped in secondary inclusions formed by healing of a single crack in a crystal is ordinarily constant. Under these conditions, it is possible to determine temperature of mineral formation by examining the contents of a single inclusion. Occurrence of wide variation in the ratio of gaseous to liquid-phase volumes can occur in inclusions along a singlehealed crack; however in this case, determination of mineral-formation temperatures by this method are rendered invalid. Differences in crack formation of healing are not apparent where the phase volume ratio shows wide variation or lack of it; it is obvious in both cases that the inclusion had formed simultaneously. The temperature range involved appears untenable with distribution of inclusions and of types of included phases. Several explanations have been given for the occurrence of this wide variation of phase-volume ratios along a single crack, for example, variation could have occurred as a result of penetration of an initially nonhomogeneous solution. Observational data have provided the solution to this problem. Crack healing was rapid under high temperature conditions; it was found that solution could be isolated in pockets along the crack before significant temperature decrease. Because changes in cavity shape are a longer process, larger inclusions can remain relatively elongated. With decreasing temperature, the gas bubble forms in all inclusions along a healed crack including nonaltered cavities. Two inclusions will form by the sealing off of an elongate inclusion: the content of one inclusion will be homogeneous and of the other, a gas bubble. A sodium saltpeter crystal was used in the experiment under decreasing temperature conditions. Initial crack healing occurred at 100°C.; subsequently the system was cooled to room temperature, and change of form was studied. Presence of single inclusions of widely varying phase-volume ratios in a healed crack indicates a low-temperature decrease during changes in cavity shape and during differentiation which tends to occur in larger inclusion cavities. In order to determine homogenization temperature, phase-volume ratios should be constant in adjacent inclusions; an average determination can be made if a sufficient number of inclusions are sampled. The author concludes that this formation process is possible also in primary inclusions as a result of their differentiation during their change in shape in a matrix solution under conditions of decreasing temperature.--D. D. Fisher.

2-1225. Lemmleyn G.G., and M.O. Kliya. **NEW DATA ON THE DEPOSITION OF CRYSTAL SUBSTANCE ON CAVITY WALLS OF LIQUID INCLUSIONS. Translated by V. L. Skitsky: Internat. Geology Rev., v. 2, no. 2, p. 120-124, 7 illus., table, Feb. 1960, 6 refs.**

The concentrations of aqueous solution from which quartz, feldspar, topaz, tourmaline, and other minerals crystallize during the hydrothermal stage is important to an understanding of pegmatite formation. Two opposing theories have been advanced on solution concentration: 1) Pegmatitic minerals separate from highly concentrated solution, without marked change in concentration, by gradual cooling. 2) Pegmatitic minerals separate as a result of flow and of renovation of the exhausted contents of solutions; this need is based on low solubility of silica in pure water. Study of liquid inclusions in minerals reveals that separation of hydrothermal minerals is known to occur from aqueous solutions heavily saturated with alkaline-halide salts, carbonates, borates, and free carbonic acid. From observations made on secondary liquid inclusions in topaz samples from pegmatites, it was found that one-third of the inclusion-cavity volume was occupied by the gas bubble and the remainder of the volume largely by small crystals of several solid phases. Inclusion contents could not be completely homogenized because they exploded at 400°-450°C.; homogenization required temperatures above 500°C. Flattened inclusions, formed by healing of cracks parallel to the (001) cleavage plane, were examined. At room temperature, the included bubble was disklike; on heating to temperatures of 180°-200°C., the bubble contracted, revealing beneath it a circular crescent-shaped depression, probably an indication that crystal substance had been deposited on inclusion-cavity walls. Accordingly, crystal substance precipitated out after entrapment of solution in the cavity because redeposition occurred around the bubble; this could have been possible only after the solution had been completely enclosed and subsequently cooled. To determine the original amount of substance entrapped, measurements were made of inclusion-cavity volume, thickness of substance deposited within the cavity (found to be about 2% of inclusion-cavity height), and depth of crescent-shaped depression. From these data it was found that up to 2% volume of the topaz substance remained in dissolved state at relatively low temperatures. Deposition traces were found on walls of sufficiently flat inclusions where a large part of the wall surface was blocked by a flattened bubble; presence of these conditions was required in order to detect the deposited layer and measure its height.--D. D. Fisher.

8. MINERALOGY AND CRYSTALLOGRAPHY

See also: Igneous and Metamorphic Petrology 2-1234; Mineral Deposits 2-1277.

2-1226. Wade, F. Alton, and Richard B. Mattox. **ELEMENTS OF CRYSTALLOGRAPHY AND MINERALOGY: 332 p., illus., diags., New York, Harper & Brothers, 1960, refs.**

This text is designed for a 2-semester course in which the first semester is devoted primarily to crystallography and the second semester to the study of minerals and the geology of mineral deposits. It is assumed that a separate text or laboratory manual will be used for the study of crystals, crystal models, and minerals in the laboratory. Pictures of minerals have therefore been used in this book only when needed to illustrate some specific physical property. Some subject matter discussed in other elementary texts has been omitted, especially that dealing with the use of the petrographic microscope.

Emphasis has been placed on the constitution of matter and on the crystalline state in the first 2 chapters. Succeeding chapters deal with the classification of crystals, crystal chemistry, physical and chemical properties of minerals. In the chapter on chemical properties, much attention has been paid to the practical aspects of a wide range of qualitative tests for various elements suspected of being present in the minerals being examined in a nonquantitative fashion. For all elements normally encountered, procedures, tests, and results are catalogued. Blowpipe-analysis methods are revived. The chapter on descriptive mineralogy gives for each mineral: name, crystallization, habit, properties, composition, alteration, occurrence and mineral associations, and uses. The overall classification is a simplified version of one employed in the 7th ed. of Dana's System of Mineralogy. Following chapters deal with economic mineralogy and genetic mineralogy. An appendix on stereographic projection and an alphabetical index of mineral species conclude the text.--From auth. pref. & ed. introd.

2-1227. **Wahlstrom, Ernest E. OPTICAL CRYSTALLOGRAPHY: 3d ed., 356 p., 260 figs., New York, John Wiley & Sons, 1960.**

This book presents the elementary theory of optical crystallography with special reference to the use f the polarizing microscope in the examination of onopaque crystalline substances. The treatment is esigned for the beginning student and develops the eory with the aid of numerous diagrams. Mathematical derivations are kept at a minimum. Procedures for measurement of all optical constants are utlined in detail. A chapter on the use of the 4-xis universal stage is included.--Auth.

2-1228. Flagg, A. L. COLOR MAGIC IN FLUORESCENT MINERALS: Arizona Highways, v. 36, no. 1, 24-31, illus., Jan. 1960.

Fluorescence in minerals has been recognized ince the early 17th century. Related phenomena nclude thermoluminescence, chemiluminescence, riboluminescence, and phosphorescence. The mechanism and uses of luminescence are reviewed; minerals exhibiting this property, with emphasis on those rom Arizona, are named. Photographs in color show ne luminescent properties of willemite, sphalerite, alcite, chalcedony, hydrozincite, calcium-larsenite, uorite, scheelite, scapolite, and opalite. Instructions for photographing luminescence are given.--M. ussell.

2-1229. Bish, Harry J. ROCKHOUNDING IN COLOMBIA: Lapidary Jour., v. 13, no. 6, p. 770-72, 8 illus., Feb. 1960.

Extensive gravel deposits containing large quantities of wood replaced by chalcedony and opal occur n both sides of the Magdalena River in a belt of pproximately 50 mi. in width and 150 mi. in length; ne position of this belt is not fixed, however, samples of petrified wood, carnelian, and agate were ollected in the vicinity of Porto Boyaca. Petrified ood is reported as more abundant upstream from Barranca. The material is stated to be colorful and of excellent lapidary quality. Spoil banks left by gold dredges operating in the area contain many examples of wood and other chalcedony varieties. The wood is stated to be guaycan.--J. Sinkankas.

2-1230. Gordon, Samuel G. THE MINERALOGY OF PENNSYLVANIA: Acad. Nat. Sci., of Philadelphia, Spec. Pub. no. 1 (A.N.S.P. Reprint No. 1), 255 p., 108 illus., 2 tables, 1959, approx. 300 refs.

The third printing of a book originally published in 1922 and again in 1954. This printing differs from the earlier ones only in that it has a new cover and slightly reduced page size.--M. Russell.

Contents:
Introduction.
Origin and occurrence of minerals.
General geology of Pennsylvania.
Descriptive mineralogy of Pennsylvania.
Mineral localities of Pennsylvania.
Bibliography.

2-1231. Dietrich, Richard V. VIRGINIA MINERALS AND ROCKS: 3d ed., Virginia Polytech. Inst., Bull., v. 53, no. 3, (Eng. Expt. Sta. Ser. no. 137), 59 p., 52 illus., 2 maps, 2 diags., tables, Jan. 1960, 55 refs.

This handbook is designed to supply in concise and nontechnical form the type of information sought by secondary school students, 4-H Club members, Boy Scouts, Girl Scouts, and members of nature study groups interested in collecting and studying minerals and rocks. Sections of only general application are: minerals, rocks, gems and gem materials, utilization of minerals and rocks, and mineral determination tables. Sections specifically applicable to Virginia geology are: Virginia's scenic rocks, check list of Virginia minerals, and Virginia mineral localities by County.--From pref.

9. IGNEOUS AND METAMORPHIC PETROLOGY

See also: Areal and Regional Geology 2-1082, 2-1083, -1084, 2-1110; Structural Geology 2-1123; Geophysics -1168; Geochemistry 2-1200, 2-1214, 2-1225; Mineralo- 2-1231; Mineral Deposits 2-1248.

2-1232. Winkler, Helmut G. F., and Hilmar von aten. EXPERIMENTELLE GESTEINSMETAMORPHOSE - III. ANATEKTISCHE ULTRAMETAMORPHOSE KALKHALTIGER TONE [EXPERIMENTAL OCK METAMORPHISM - III. ANATECTIC ULTRAMETAMORPHISM OF CALCAREOUS CLAYS]: Geochim. et Cosmochim. Acta, v. 18, no. 3/4, p. 294-6, 3 diags., 7 tables, Feb. 1960, 21 refs.; text German, abs. in English.

Calcite-bearing illitic clays with different content Na_2O were hydrothermally and isochemically eated at 2,000 at H_2O pressure. At 740°C. ultrametamorphism begins by formation of an anatectic elt. The melt consists initially of K-feldspar and artz, to which plagioclase, more quartz, and afics join with small rise in temperature. The mposition of the melts changes from aplitic to anitic and granodioritic. Comparison is made of ese melts with those aplitic and granitic melts rmed by ultrametamorphism of calcite-free clays. specially, it has been found that the temperature of atectic formation of a granitic melt can vary as much as 100°C., depending on the ratio anorthite/albite in the metamorphic rock prior to the formation of melt. This is due to fractional melting of alkali-feldspar and plagioclase, which has been demonstrated experimentally.

The amount of anatectic melt comprises up to 80% of the metamorphosed clay. The unliquefied crystals are predominantly An-rich plagioclases which are accompanied by mafics, seldom by a little quartz. This leads to the suggestion that anorthosites might possibly also be looked upon as the crystalline remainder not liquefied in the course of ultrametamorphism of calcite-bearing illitic clays or shales. Separation of crystals and melt yields palingenic granite-granodiorite magma and anorthositic rocks. --Auth.

2-1233. GEOLOGICAL SURVEY VOLCANOLOGISTS STUDY NEW SERIES OF ERUPTIONS AT HAWAII'S KILAUEA: Science, v. 130, no. 3390, p. 1695-1697, 2 illus., Dec. 18, 1959.

Between Nov. 14 and Dec. 5, 1959, Kilauea Iki (on the rim of the volcano Kilauea, in the Hawaii National Park) erupted 5 times. The activity was recorded by means of tiltmeters, seismographs, and gravimeters, as well as by measurements of volume, rate of flow, and temperature. Variations in temperature were correlated with the changing mineralogic character of the exutate materials. Seismic activity is continuing, further disturbances are expected and will be watched.--B. C. Schreiber.

2-1234. Kostyuk, V.P. ON THE MAGNESIUM-IRON MINERALS OF SCHISTS OF THE BUGITE COMPLEX. Translated by A.J. Shneiderov: Internat. Geology Rev., v. 2, no. 2, p. 129-133, diag., table, Feb. 1960, 8 refs.

Schists of the Bugite complex of the Ukrainian ma sif contain the mineral assemblages: cordierite (Fe$_{25}$)-garnet (Fe$_{64}$)-quartz-sillimanite, cordierite (Fe$_{25}$)-garnet (Fe$_{64}$)-hypersthene (Fe$_{41}$), and garnet hypersthene (Fe$_{52}$), with percentages of ferrous end members given by the Fe-subscripts. Chemical analyses and optical data are given for cordierite an garnet from the first assemblage, and of hypersthen from the second and third assemblages. These assemblages and the related ones are plotted on a Korzhinsky-type ternary diagram of components Al$_2$O$_3$, FeO, MgO, and with SiO$_2$ present in excess amounts.--F. Barker.

10. SEDIMENTARY PETROLOGY

See also: Areal and Regional Geology 2-1056, 2-1060, 2-1062, 2-1064; Stratigraphy 2-1132, 2-1133, 2-1135, 2-1137, 2-1139; Geochemistry 2-1202, 1-1217; Fuels 2-1288.

2-1235. Carozzi, Albert V. MICROSCOPIC SEDIMENTARY PETROGRAPHY: 485 p., 88 illus., New York, John Wiley & Sons, 1960, 562 refs.

The book is based on the concept of "ideal" descriptions of sedimentary rock-types which summarize both the most common appearance of a given rock-type as well as those variations which have broad significance. The ideal descriptions have been worked out through the combination and integration of as many particular descriptions of rock-types as the author was able to find in the American and European literature. The major subdivisions of the book are following:

- CLASTIC ROCKS
  - Arenaceous Rocks
  - Rudaceous Rocks
  - Pyroclastic Rocks
  - Argillaceous Rocks
- BIOCHEMICAL ROCKS
  - Carbonate Rocks
  - Siliceous Rocks
  - Iron-bearing Rocks
  - Phosphoritic Rocks
- CHEMICAL ROCKS
  - Evaporitic Rocks

Among arenaceous rocks a great deal of space has been devoted to the description of the pure quartz sandstone series and of cementation processes in the different series of sandstones. The coverage of rudaceous rocks includes hybrid rocks such as the peperite breccias which lead to a rather extensive treatment of pyroclastic rocks with emphasis on ignimbrites.

The book contains a complete microscopic description of argillaceous rocks, a field which has been strongly neglected in favor of more elaborate techniques such as X-ray investigation, but which still remains of basic importance. An exhaustive chapter has been dedicated to carbonate rocks, with particular emphasis on oölitization and dolomitizatio processes and their petrographic expression. Siliceous, Fe-bearing and phosphatic rocks are examine also in detail, and the final chapter is dedicated to th strikingly diversified petrography of evaporitic rocks --Auth.

2-1236. Botvinkina, L.N. ON THE CLASSIFICATION OF VARIOUS BEDDING TYPES. Translated by P. Fitzgerald Moore: Internat. Geology Rev., v. 2, no. 2, p. 159-166, 3 illus., diag., Feb. 1960, 5 refs.

The author presents his classification of bedding types for sedimentary rocks. Several earlier classifications reviewed here have not been adequate for standardization of terminology or classification. Analogous bedding types have been found to occur in rocks of varied origin, so that it has been difficult to formulate classifications based solely on the genesis of structural types; conversely, a purely structural classification is inadequate as well. A classification proposed by Zhemchuzhnikov in 1926, was organized according to bedding form (type) and bedding dimension (subtype). In 1940, he revised his classification stating that all distinguishing criteria of bedding could be arranged in 3 groups: 1) criteria displayed by individual beds, 2) criteria peculiar to bedding sets, and 3) criteria indicative of the cause of bedding. The author uses these crite ria as the basis for his proposed classification. The first 2 groups are structural criteria, the third, genetic. A fourth category of the Zhemchuzhnikov classification, including conditions for stratification, is incorporated under group 3. Hypothetical examples illustrating use of this classification to describe 3 types of sedimentary deposits are given. Additional research according to the author is necessary on classification of unbedded structures as well as on preparation of a unified genetic classification of structures.--D. D. Fisher.

11. GEOHYDROLOGY

See also: Geomorphology 2-1118.

2-1237. Anderson, Duwayne M., and A. Linville. TEMPERATURE FLUCTUATIONS ACCOMPANYING WATER MOVEMENT THROUGH POROUS MEDIA: Science, v. 131, no. 3410, p. 1370-1371, graph, May 6, 1960, 6 refs.

Temperature measurements were made at localized sites in bentonite, kaolinite, and small glass beads during infiltration. The temperature of the medium was observed to rise gradually and then to drop sharply as the infiltrating water approached an reached the measurement site. Temperature fluctu ations were observed to be about 9°C. for bentonite, 4°C. for kaolinite, and 0.1°C. for the glass beads.--Auth.

2-1238. Stewart, Herbert G., Jr. INTERIM REPORT ON THE GEOLOGY AND GROUND-WATER RESOURCES OF NORTHWESTERN POLK COUNTY, FLORIDA: Florida Geol. Survey, Inf. Circ. no. 23, 3 p., 5 maps (3 fold.), sec., diag., 26 graphs, 9 tables, 1959, 38 refs.

The entire area of northwestern Polk County is underlain by limestone from 25 to 100 ft. below the land surface to a depth of several thousand feet. The upper limestones (middle Eocene to middle Miocene) are the principal sources of water supplies in this area. The limestones dip gently southwestward, and are overlain by Miocene, Pliocene, and Pleistocene clastics. The Pleistocene covers the entire area and varies in thickness from 1 to 100 ft.

Ground water occurs under both artesian and nonartesian conditions. The top of the zone of saturation is close to the land surface in much of the area, and fresh water extends downward to an unknown depth. The nonartesian aquifer consists of Pleistocene and Recent sand. The uppermost artesian aquifer is in the lower part of the Bone Valley formation [Pliocene]. The secondary artesian aquifer, composed of middle Miocene limestone, supplies water for domestic and small irrigation requirements.

The Floridan aquifer is the principal source of ground water in the area. Wells drilled into this aquifer range from 3 to 26 in. in diameter and from 150 to 1,200 ft. in depth. The records show a net decline of water levels in the Floridan aquifer between 1936 and July 1956; the decline is believed to be due primarily to below-average rainfall from Jan. 1954 to July 1956.

In the Lakeland area, some recharge of the Floridan aquifer may come from the lakes. Most of the downward leakage from some of these lakes is apparently recharging the secondary artesian aquifer. Lake Parker recharges the artesian aquifers at a low rate. Scott Lake is recharging the secondary artesian aquifer. The large seasonal decline of its level is thought to be due to continuing downward leakage to the secondary artesian aquifer, evaporation, and below-normal rainfall.--H. S. Puri.

2-1239. LeGrand, Harry E. A SUMMARY OF GROUND-WATER CONDITIONS IN THE PIEDMONT PROVINCE OF VIRGINIA: Virginia Minerals, v. 5, no. 4, p. 1-7, map, sec., diag., Oct. 1959.

General information is presented about the ground-water resources of this wide belt of rolling land between the Coastal Plain on the E. and the Blue Ridge Mountains on the W. Ground water may be considered as occurring in an underground reservoir, the water being held in the open spaces of the rock material. The water table approximately conforms to surface topography although it is somewhat flatter. The relation of depth of a well to yield is not simple; although there is usually a good chance of increasing yield with greater depth, 2 wells of relatively shallow depth will nearly always yield more than 1 well twice as deep. Although wells on smooth upland slopes may be convenient and apparently safer from contamination, higher yield can be expected from wells dug in lowlands and draws. Wells generally are more productive and yield more uniform flow throughout the year where a thick soil mantle occurs than where bare rock crops out. Rocks in the Virginia Piedmont fall into 2 general classes in respect to their ground-water properties: 1) somewhat massive igneous rocks such as granite, and 2) metamorphic rocks such as schists, gneisses, and slate which may show an alignment of minerals, cleavage planes, or openings along which water may move. Pumping water from a well results in drawdown, which increases with an increase in rate of pumping but not in simple relation. Some wells pumped heavily decline gradually in yield; constant pumping at a moderate rate does not damage a well. Water from rocks underlying light-colored soil is generally soft and low in dissolved mineral; water from rocks underlying darker soils is generally hard and may have objectional amounts of Fe.--M. Russell.

2-1240. Assovsky, G.N. GROUND WATER IN PALEOZOIC FORMATIONS OF THE NORTHERN SHILOVO-VLADIMIR DEPRESSION. Translated by Research International: Internat. Geology Rev., v. 2, no. 1, p. 60-67, 2 maps, 2 tables, Jan. 1960, 6 refs.

Drilling in the Shilovo-Vladimir depression has demonstrated that *Schwagerina* dolomites and limestones are overlain by Tatarian marls; therefore, Kazanian sediments are absent in this region and cannot adversely affect ground water from upper Carboniferous aquifers. In rocks of the Kazanian stage, occurring in the northeastern part of the depression, ground water is highly mineralized. Ground water in upper Paleozoic formations flows from the eastern and western flanks of the northern part of the depression and, from the Gus-Khrustalnyy region, flows S. to N. Ground water mineralization in the *Schwagerina* dolomites and limestones in 2.8 g. per l., from middle Carboniferous aquifers, 16.5 g. per l.--Research International.

12. MINERAL DEPOSITS

See also: Geologic Maps 2-1042, 2-1043; Areal and Regional Geology 2-1050, 2-1108, 2-1109; Geophysics 2-1174; Geochemistry 2-1218.

2-1241. Robie, Edward H., *ed.*, and others. ECONOMICS OF THE MINERAL INDUSTRIES: 755 ., 53 illus., 128 tables, New York, American Institute of Mining, Metallurgical, and Petroleum Engineers, 1959, 575 refs.

The significance of the mineral industries in the economy, as discussed in the first chapter, gives a short history of the mineral industry and its important aspects. Its distinctive features are then considered from the technical standpoint, in prospecting, exploration, and mine development; in mining, concentrating, and recovering the metal from the ore. The legal phases of the ownership of mining property are next covered in the chapter on mineral titles and tenure. This includes a summary of foreign mineral laws as well. How mineral properties are valued is then given attention, with a hypothetical mine as an example. The cost of acquiring and operating mineral properties of various types - metallic, nonmetallic, and the mineral fuels - is illustrated with numerous examples, including some in Canada.

The various methods of financing, and the sources of capital funds for mine development are explained, including the securing of bank loans on oil and gas production. Marketing is treated in sections devoted to ores and metals, industrial nonmetallic minerals, coal, and petroleum and natural gas. Changing patterns of supply and demand, and controlling factors are explained.

Accounting is covered from the point of view of those who use the information and statements rather than of those who prepare them; a special section is devoted to petroleum accounting. A brief history is given of mining taxation in the United States, and of its present status, with practical hints for taxpayers. Political aspects of the mineral industry are covered in a chapter on minerals in national and international affairs, wherein the principle of self-sufficiency and stockpiling, for example, are given attention. Government aid and regulation, and conservation and stabilization are discussed at some length. The history of relations between labor unions and management in the mining industry is given attention. Industrial research - its aims, organization, and facilities - are covered. A historical chapter on gold and silver, money and credit, is followed by a final one on nuclear energy, and what can be expected in the future.--E. H. Robie.

2-1242. Nolan, Thomas B. THE PLACE OF GEOLOGY IN THE DEVELOPMENT OF THE MINING INDUSTRY: Mines Mag., v. 50, no. 2, p. 20-22, 27, Feb. 1960.

The U. S. Geological Survey provides valuable aids to prospecting for new ore bodies. New mining and milling methods must be devised to cope with lower grades of deposits.--Worldwide Oil & Gas Abstracts, v. 7, no. 2, p. 11, March-Apr. 1960, abs. 72-B26.

2-1243. Anderson, Charles A. MINING GEOLOGY: Mining Cong. Jour., v. 46, no. 2, p. 38-41, 2 illus., Feb. 1960.

In order to find how ore deposits are formed, researchers are studying basic geological problems. Some of these basic problems include: geochemistry, silicate studies, carbonate minerals, ore-forming fluid, isotope distribution, and geophysics.--Worldwide Oil & Gas Abstracts, v. 7, no. 2, p. 11, March-Apr. 1960, abs. 72-B25.

2-1244. Ames, L. L., Jr. SOME CATION SUBSTITUTIONS DURING THE FORMATION OF PHOSPHORITE FROM CALCITE: Econ. Geology, v. 55, no. 2, p. 354-362, 14 diags., March-Apr. 1960, 14 refs.

The nature of cation substitution during replacement of calcite by phosphorite allows the statistical treatment of data concerning such substitutions. Log-probability plots of data yield straight lines that allow easy and accurate extrapolations. Data are presented to show the effect of PO_4^{-3} concentration, temperature, flow rate, and Na^+ concentration on the primary inclusion of the radioisotopes of Pm^{+3}, Sr^{+2}, U^{VI}, and Pu^{IV}.--Auth.

2-1245. Baker, Arthur, 3d. CHALCOPYRITE BLEBS IN SPHALERITE AT JOHNSON CAMP, ARIZONA: Econ. Geology, v. 55, no. 2, p. 387-398, 3 illus., 3 maps, 4 secs., March-Apr. 1960, 8 refs.

Pyrometasomatic sphalerite-chalcopyrite deposits at Johnson Camp are pipes as much as 2,000 ft. long, formed along bedding-plane channelways of mineralizing solutions rather than at the intersections of crosscutting channels with favorable beds. Nearly all of the sphalerite contains numerous microscopi blebs of chalcopyrite. The principal control for variations in the abundance and size of these blebs is stratigraphic, and an attempt to use bleb pattern as a guide to new ore failed because of this stratigraphic control. Blebs are not present in ore that contains bornite. The blebs originated by exsolutio as the ore deposits cooled but before the minerali solutions stopped circulating.--Auth.

2-1246. Bloom, Harold. GEOCHEMICAL PROSPECTING: Mines Mag., v. 50, no. 1, p. 12-16, Ja 1960.

Chemical analysis of soil, vegetation, and strea waters and sediments may yield data indicative of subsurface mineral concentrations. Discovery of porphyry Cu in Armenia is described.--Worldwide Oil & Gas Abstracts, v. 7, no. 2, p. 12, March-Ap 1960, abs. 72-C5.

2-1247. Dolukhanova, N.I. AN EXPERIMENT IN THE APPLICATION OF HYDROCHEMICAL SURVE TO COPPER AND MOLYBDENUM DEPOSITS IN TH ARMENIAN S.S.R. Translated by William Mandel: Internat. Geology Rev., v. 2, no. 1, p. 20-42, 4 maps, 3 profiles, 3 diags., 2 graphs, 5 tables, Jan 1960, 5 refs.

Mo and Cu-Mo ore concentrations may be detect by soil and hydrochemical surveying technique. A general chemical description of Mo, the various mi eral forms in which it occurs, and the conditions of reaction are given. Physical geography, particular relief, and rainfall are predominant factors governing the behavior of Mo in the oxidation zone. Mo di persion halos at the Dasta Kert, Agarak, Kadzhara and Ankavan deposits, Armenian S. S. R., were studied to test the method of surveying.--M. Russel

2-1248. Bartholomé, Paul M. GENESIS OF THE GORE MOUNTAIN GARNET DEPOSIT, NEW YORK: Econ. Geology, v. 55, no. 2, p. 255-277, 6 illus., 2 maps, 2 diags., 8 tables, March-Apr. 1960, 26 refs.

In the S.-central Adirondacks, garnet porphyroblasts are found in rocks of various compositions and origins. However, they are abundant only in basic rocks. Their shape, habit, size, and composition depend on the nature of the host rock. The are commonly surrounded by rims or shells whose composition also depends on the nature of the host rock. On the other hand, garnet porphyroblasts ar not found in basic rocks that have kept relics of the magmatic texture and mineralogy. Such rocks contain garnet only as coronas. These observations show that garnet porphyroblasts have grown in situ after a period of intense componental movements.

The available chemical data suggest that the formation of the Barton mines dark ore results fro a process of metamorphic differentiation taking pla during a period of rising temperature. There is n reason to suppose that metasomatic changes have been important.--Auth.

2-1249. Kashirtseva, M. F. EXPERIMENTAL DATA ON SORPTION OF COPPER BY VARIOUS MINERALS AND ORGANIC SORBING AGENTS. Tra lated by Research International: Internat. Geology Rev., v. 2, no. 1, p. 52-59, sec., diag., 8 tables Jan. 1960, 9 refs.

Experimental data on Cu sorption by organic and neral sorbing agents have shown that sorption can e place from very dilute solutions. The degree sorption depends on the total amount of dissolved in solution, the velocity of the circulating solu- n, the duration of contact between the sorbent and sh solutions, and the degree of diffusion of the lution within the sorbent. Organic matter, namely e loam, peat, lignite, and humic acid, absorbs from very dilute solutions (from $2x10^{-4}$ to $2x10^{-5}$ per l. Cu concentrations, 2.5 to 4.5%); other sor- nts, namely, sand, kaolin, feldspar, and quartz, sorb one-tenth as much as the organic sorbents. sorption is very slight in organic material; it is most complete in mineral sorbents. It is believed t sorption plays a very significant part in the for- tion of sedimentary Cu deposits, particularly in Cu sandstones of the Urals.--Auth.

1250. White, Walter S. THE WHITE PINE COP- R DEPOSIT: Econ. Geology, v. 55, no. 2, p. 402- 0, March-Apr. 1960, 6 refs.

Discussion of a paper on this deposit, Ontonagon unty, Michigan, by W. S. White and J. C. Wright con. Geology, 1954, v. 49, p. 675-716). Four neral theories of origin may satisfy the observed ological conditions: 1) the Cu was deposited with e original mud; 2) the Cu, diffusing downward into e uppermost few inches of mud, replaced some imary constituent; 3) the Cu was introduced into e shales from below, prior to final compaction or formation; 4) the Cu was introduced into the rock er lithification and deformation. The fourth theo- is rejected on several counts. The third is favor- . The theory of a pretectonic origin for Cu finds pport in the distribution and disposition of Cu in ale and sandstone and in the fact that fractures ow little relation to shale-ore zones. The typical yolites of the region appear to be older than the nesuch shale.--J. A. Chamberlain.

1251. Joklik, G. F. THE DISCOVERY OF A PPER-ZINC DEPOSIT AT GARON LAKE, QUE- C: Econ. Geology, v. 55, no. 2, p. 338-353, 6 s. incl. 4 maps, March-Apr. 1960, 11 refs.

An exploration venture that led to the discovery of small ore-grade Cu deposit in the very active Mat- gami Lake exploration area of northwestern Que- c is described.

The Garon Lake property was staked to cover a hall, isolated E. M. anomaly that was recorded ring an airborne survey of a folded post-Keewatin sic intrusion. A ground geophysical survey con- med the presence of a narrow but good conductor d of a coincident, positive magnetic anomaly. Dia- ond drilling has indicated the presence of a body of assive sulfides containing a little over 2% Cu.

The sulfide deposit is in a group of metamorphosed ewatin lavas, tuffs, and sediments intruded by old- gabbro and by systems of late unmetamorphosed kes, of which lamprophyre, olivine diabase, and oite granite, are examples. The strike and dip of e mineralization are essentially parallel to the rike and dip of the country rock. The shoot of mas- ve sulfides plunges at about 60°. Pyrrhotite, py- e, chalcopyrite, and sphalerite occur in varying oportions and show textural evidence of having re- aced the pre-existing rock.

The mineralization is near the contact between nphibolite (derived from lavas) and quartz-rich hist (derived from sediments). More particularly, the sulfide body is closely associated with an alteration aureole of cordierite-anthophyllite hornfels. Examples of base metal sulfide deposits that are structurally and genetically related to the formation of Mg-rich cordierite-bearing metasomatic zones have been described from other parts of the world. Geographically the closest described example is the Amulet ore body in the Noranda district. The discovery of this type of deposit on the Garon Lake property sheds new light on exploration in the Mattagami Lake area.--Auth.

2-1252. Davidson, D. F. SELENIUM IN SOME EPITHERMAL DEPOSITS OF ANTIMONY, MERCURY, AND SILVER AND GOLD: U.S. Geol. Survey, Bull. 1112-A, p. 1-16, 2 maps, 6 tables, 1960, 18 refs.

The presence of Se in some epithermal ores of Ag, Au, and Hg has long been known. Recent work indicates that epithermal Ag and Sb deposits are commonly highly seleniferous and that Au and Hg deposits are only rarely so.

Se in Ag and Sb deposits is associated with these metals in ore minerals and is not found in other minerals of the deposits. The relation with ore minerals also occurs in the few Au and Hg deposits which contain Se.

Most published reports suggest that Ag and Sb deposits are related genetically to crystalline igneous rocks. Se in Ag and Sb deposits may have been liberated from crystallizing magma as a part of the process of crystallization and thus have been made available for deposition with the ore metals.--Auth.

2-1253. Alekseev, V.V., A.G. Grammakov, A.I. Nikonov, and G.P. Tafeev, eds. RADIOMETRIC METHODS IN THE PROSPECTING AND EXPLORATION OF URANIUM ORES: U.S. Atomic Energy Comm., [Pub.] AEC-tr-3738, 2 v., illus., maps, diags., graphs, tables, July 1959, approx. 175 refs.

A translation of Radiometricheskie Metody Poiskov i Razvedki Uranovykh Rud. Gosudarstvennoe Nauchno-Tekhnicheskoe Izdatelstvo Literatury po Geologii i Akhrane Nedr, Moskva, 1957.

The geophysical methods of prospecting and exploration of radioactive ores, based on the useful application of the differences in radioactivity between the mineral and its mother rock, form a part of the radiometric prospecting practices. The development of this field of exploratory geophysics is due to the growing raw-material requirements of the rapidly expanding industry of nuclear power engineering, and is closely connected with the successes achieved in the adjacent scientific branches - geochemistry and geology of the deposits of radioactive elements, the theory of radioactivity and methods of investigation of radioactive radiations, automatics, electronics, and so on. At the present time radiometric prospecting has put solid roots into the practices of search, and exploratory and mining operations.

The principal advantages of radiometry, which determine its leading role in the solution of the abovementioned problems, consist in the efficiency and speed in producing results and in the accuracy of the field and laboratory analyses. By means of radiometric methods a number of large mining areas and industrial deposits of radioactive ores were exposed in recent years in the Soviet Union and abroad.

The only published manual Geophysical Radioactive Methods in Application to Geology (published in 1934) has become obsolete at the present time. In the textbooks on exploratory geophysics put out in the recent years little attention and space have been devoted to radiometric methods. The object of the present work is to fill in the gap existing in geophysical literature, and it is designed for broad circulation among geophysical engineers and geologists, as well as for use as a manual in the special departments of the mining and geological schools.

The book consists of 4 parts. Pt. 1 is confined to a general review of the physical, geological, and geochemical principles of radiometric methods and presents an independent interest as a survey of the basic information necessary to geophysicists and geologists engaged in the special field referred to above. Pt. 2 describes the fundamental methods of measurement, the principles of the layout of radiometric apparata, the rudiments of radiometric data processing and the methods of laboratory radioactivity measurements. Pt. 3 provides an account of radiometric prospecting methods and practices used primarily in the exploration and exploitation of ore deposits. The concluding, fourth part of the book sheds light on problems of application of complex geophysical methods in divers conditions and at various stages of geological and prospecting operations dealing with radioactive ores.

The compilation of this work was fundamentally accomplished in the years 1954 to 1955.--From pref.

2-1254. Roscoe, S.M. HURONIAN URANIFEROUS CONGLOMERATES: Econ. Geology, v. 55, no. 2, p. 410-414, March-Apr. 1960, 9 refs.

Discussion of a paper by C. F. Davidson (GeoScience Abstracts 1-3144). Some "criteria" indicating a nonplacer origin for uraniferous conglomerates are criticized. One such "criterion" based on the grain size of host rock sediments relative to the grain size of uraninite is misleading because Stokes Law cannot be applied. Cases are known where radioactivity is higher in coarse clastic sediments than in adjacent fine-grained ones.

Most quartz-pebble conglomerates in the Blind River (Ontario) area contain more Th than U. There is no positive correlation between pyrite content and U content. Pyrite may be of multigenetic origin. Available evidence suggests that most other mineral assemblages, including those containing U, are of placer origin.--J. A. Chamberlain.

2-1255. U.S. Geological Survey. URANIUM IN COAL IN THE WESTERN UNITED STATES: Its: Bull. 1055, 315 p., 59 pls. (47 under separate cover), 44 figs. incl. maps, secs., diags., 45 tables, 1959, refs.

Information on the historical background of studies on U-bearing coals, the source and accumulation of U, possible economic value of U-bearing coal, and guides in evaluating evidence for U-bearing coal in unexplored areas is presented in the introduction by Norman M. Denson.

"During the 5-year period 1950-1954, the U. S. Geological Survey made extensive investigations of the occurrence and distribution of U in coal and related carbonaceous materials throughout large areas in the western United States. . .These investigations have shown that several large coal deposits in the Tertiary basins of the Rocky Mountain and the Great Plains regions contain very low-grade concentrations of U. The U content of the coal in these deposits is not uniform but ranges from about 0.005 to 0.02%. Within the low-grade U-bearing coal deposits, smaller irregular masses of coal containing 0.1% or more U have been found in places. A number of U mineral including autunite, zeunerite, torbernite, carnotite, becquerelite, and coffinite have been identified in th higher grade uraniferous coals, but much of the U is inconspicuously disseminated in the carbonaceous material. In the larger and lower grade deposits individual U minerals have not been identified. The U is disseminated in the carbonaceous material." --From introd.

The 9 papers included in this bulletin are separately abstracted below in the order in which they appear in the bulletin.

2-1256. Denson, Norman M., George O. Bachma and Howard D. Zeller. URANIUM-BEARING LIGNITE IN NORTHWESTERN SOUTH DAKOTA AND ADJACENT STATES (In: U.S. Geological Survey. Uranium in Coal in the Western United States: Its: Bull. 1055, p. 11-57, 2 maps, 3 secs., 2 diags., 16 pls. (10 under separate cover), 5 tables, 1959) 39 refs.

In northwestern South Dakota and adjacent areas, U-bearing lignite beds occur at many horizons in th Hell Creek formation of Late Cretaceous age and in the overlying Ludlow, Tongue River, and Sentinel Butte members of the Fort Union formation of Paleocene age. Analyses for U of 275 samples of lignite taken from outcrops or obtained by auger-drilling and of about 1,000 core samples of lignite show that many of the lignite beds contain 0.005-0.02% U, and their ash contains 0.05-0.10%. Analytical data also indicate that the region contains an aggregate of at least 47,500,000 tons of lignite having an average U content of slightly more than 0.008%. Almost a fift of the lignite occurs in beds suitable for strip minin and averaging about 4 ft. in thickness. Recent discoveries of ore-grade deposits of autunite-bearing lignite and of secondary minerals of U in carbonaceous sandstone at Cave Hills and Slim Buttes indicate that northwestern South Dakota and adjacent areas may contain important deposits of U minerals.

The stratigraphic units containing the uraniferous lignite beds have a combined thickness of about 1,50 ft. and are unconformably overlain by a sequence of 300 ft. or more of tuffaceous sandstone and bentonit claystone of the White River group of Oligocene age and the Arikaree formation of Miocene age. The stratigraphically highest lignite beds in the area hav the greatest content of U, and the concentration of U is greatest at the top of thick lignite beds, diminishing progressively downward to a vanishing point in their lower parts. Variations in permeability of the rocks overlying the mineralized lignite beds see to be related to the concentration of U. Most of the known beds of U-bearing lignite in the region are closely overlain by rocks of the White River group and the Arikaree formation, which have about 12 times more U than the average sedimentary rock. Furthermore, the U content of spring water from these formations is 30 or more times that of normal ground water. The presence of U in the lignite is independent of the age of the formation in which the lignite occurs. Field relations thus suggest that the U is of secondary origin and has been introduced after the accumulation and marked regional uplift and warping of the lignite beds and associated rocks.

The U is believed to have been a finely disseminated constituent of the overlying mildly radioactive volcanic ash and was released or displaced during weathering, and carried - probably in the ionic form - by downward and laterally moving ground waters. Carbonaceous material - lignite or carbonaceous shale - is believed to have taken the U from lution by ion exchange or by the formation of gano-metallic compounds.

Geologic factors that seem most significant in ntrolling the distribution and concentration of U in ese beds of lignite are the following: 1) stratigraph- proximity of the lignite to the base of White River oup, 2) permeability of the rocks overlying the nites, 3) adsorptive properties and porosities of e constituents of lignite, 4) present and past posi- on of the ground-water table; and 5) the amount of in the original White River and Arikaree sediments. Auth.

1257. Zeller, Howard D., and James M. Schopf. ORE DRILLING FOR URANIUM-BEARING LIGNITE HARDING AND PERKINS COUNTIES, SOUTH DA- OTA, AND BOWMAN COUNTY, NORTH DAKOTA : U.S. Geological Survey. Uranium in Coal in the estern United States: Its: Bull. 1055, p. 59-95, 3 aps, chart, 5 pls. (under separate cover), 6 tables, 59) 6 refs.

Twenty core holes having a total footage of 1,907 were drilled and from them 94 ft. of lignite were ken for analyses for U during part of the summers 1951 and 1952 in northwestern South Dakota and uthwestern North Dakota.

About 9 million tons of lignite averaging 0.01% U e estimated to be present in the areas covered by is report. The results of 191 chemical determina- ons for U show that generally the greatest concen- ations of U are in the upper parts of U-bearing nite beds 3 ft. or more in thickness and that the content decreases downward to near the vanishing int in succeeding lower beds. The results of 191 miquantitative spectrographic analyses of the ash om the lignite cores reveal that Mo closely paral- ls U in distribution and concentration and may pos- bly be significant as an indicator element in pros- ecting for U.--Auth.

1258. Gill, James R., Howard D. Zeller, and mes M. Schopf. CORE DRILLING FOR URANIUM- EARING LIGNITE, MENDENHALL AREA, HARD- G COUNTY, SOUTH DAKOTA (In: U.S. Geological rvey. Uranium in Coal in the Western United ates: Its: Bull. 1055, p. 97-146, 4 maps, 2 logs, pls. (under separate cover), 9 tables, 1959) 10 refs.

Core drilling for data on U-bearing lignite in the endenhall area, near the center of the Slim Buttes, arding County, was conducted by the U. S. Geolog- al Survey in the summer of 1951 and by the U. S. reau of Mines during the period Oct. 1952-July 53. Samples from 49 core holes having a total otage of 11,146 ft. drilled in an area of about 9 sq. i., indicate reserve of about 127 million tons of gnite, of which about 49 million tons contain an erage of 0.005% U or more. The U-bearing lignite erages 5.4 ft. in thickness and occurs in the Lud- w member of the Fort Union formation of Paleocene e.

Fuel analyses of about 130 samples indicate that e lignite contains about 15% ash, 37% moisture, % fixed C, 24% volatile matter, and 1.5% S and has heating value of about 5,800 B.t.u. (as received ndition).

In the Slim Buttes, exclusive of the Mendenhall ea, approximately 60 sq. mi. are underlain by U- aring lignite having an average thickness of 5 ft. d an average U content of 0.007% or more, and ving a potential reserve of 340 million tons of U- aring lignite.

The core samples indicate only the stratigraphically highest lignite bed beneath the unconformity at the base of the Chadron formation of Oligocene age contains appreciable quantities of U. Data indicate that the U in the lignite is of secondary origin, having been leached and transported by ground water from the mildly radioactive tuffaceous rocks that unconformably overlie the lignite-bearing strata.--Auth.

2-1259. Moore, George W., Robert E. Melin, and Roy C. Kepferle. URANIUM-BEARING LIGNITE IN SOUTHWESTERN NORTH DAKOTA (In: U.S. Geological Survey. Uranium in Coal in the Western United States: Its: Bull. 1055, p. 147-166, 7 maps, 2 secs., 3 pls. (under separate cover), table, 1959) 12 refs.

Beds of U-bearing lignite were mapped and sampled in the Bullion Butte, Sentinel Butte, HT Butte, and Chalky Buttes areas in southwestern North Dakota; they occur at several stratigraphic positions in the Sentinel Butte member of the Fort Union formation of Paleocene age. A total of 261 samples from 85 localities were collected for U analysis. Lignite containing as much as 0.045% U, 10.0% ash, and 0.45% U in the ash was found; the average U content of the lignite is about 0.013%. About 27 million tons of lignite in beds about 2 ft. thick underlie the 4 areas. Surface samples of the lignite average more than 30% ash.

The principal factor that seems to influence the concentration of U in the lignite beds is the stratigraphic position of the beds in relation to the base of the overlying White River group of Oligocene age. All U-bearing beds closely underlie the base of the White River group. The relative concentration of U is modified by other factors, however, as beds enclosed in permeable rocks are more uraniferous than beds in impermeable rocks, and thin beds have a greater U content than thick beds. In addition, a thick lignite bed commonly has a greater concentration in the top part of the bed. These and other factors suggest that the U is of secondary origin and that it was leached from volcanic ash in overlying rocks of Oligocene and Miocene age. Probably the U is held in the lignite as part of a metallo-organic compound.--Auth.

2-1260. Gill, James R. RECONNAISSANCE FOR URANIUM IN THE EKALAKA LIGNITE FIELD, CARTER COUNTY, MONTANA (In: U.S. Geological Survey. Uranium in Coal in the Western United States: Its: Bull. 1055, p. 167-179, 2 maps, 3 pls., (under separate cover), 3 tables, 1959) 6 refs.

Beds of U-bearing lignite 1.5 to 8 ft. thick occur in the Fort Union formation [Paleocene] of the southern part of the Ekalaka Hills, Carter County. Data from surface outcrops indicate that an area of about 1,400 acres is underlain by 16.5 million tons of U-bearing lignite. The U content of the lignite beds ranges from 0.001 to 0.034%, the average being about 0.005%.

Ironstone concretions in the beds of massive coarse-grained sandstone in the upper part of the Fort Union formation contain 0.005% U in the northern and eastern parts of the area. These beds of sandstone are favorable host rocks for U occurrences and are lithologically similar to beds of massive coarse-grained sandstone of the Wasatch formation in the Pumpkin Buttes area of the Powder River basin. --Auth.

2-1261. Masursky, Harold, and George N. Pipiringos. URANIUM-BEARING COAL IN THE RED DESERT AREA, SWEETWATER COUNTY, WYOMING (In: U.S. Geological Survey. Uranium in Coal in the Western United States: Its: Bull. 1055, p. 181-215, map, 3 secs., 2 graphs, 10 pls. (under separate cover), 4 tables, 1959) 17 refs.

U-bearing coal occurs in the Red Desert area of Sweetwater County, in a zone 15 mi. wide which extends in a northwesterly direction for 30 mi. N. of Wamsutter, Wyoming. The thickest coal is found along the transition zone between the fluviatile sandstone of the Wasatch formation and the lacustrine shale of the Green River formation, both of Eocene age. Each coal bed is lenticular and grades into shale to the NE. and SW.

The greatest concentrations of U in the coal occur locally where the beds are overlain by conglomerate of possible Miocene age. Widespread but lesser concentrations of U occur in coal where a bed is in proximity to intercalations of coarse-grained, permeable, fluviatile sandstone which were derived from a source area to the NE. The close relationship between U in the coal and the permeability of the adjacent beds indicates that the U was of epigenetic origin.

Preliminary estimates indicate that the rocks in the mapped area contain about 700 million short tons of subbituminous B coal in beds not less than 2.5 ft. thick and overlain by not more than 75 ft. of overburden. The Luman No. 1 coal bed, the principal objective of a drilling program in 1952, contains about 12 million short tons of subbituminous coal that averages 3.9 ft. in thickness, under not more than 75 ft. of overburden. The U content of the Luman No. 1 bed averages about 0.006%, the ash content averages about 20%, and the U content of the ash averages about 0.030%. The average heating value of the coal in the "as received" condition is 7,600 B.t.u. The average U content of other coal in the rest of the area is about 0.003%, although locally, as at Creston Ridge in the southeastern part of the area, impure coal contains as much as 0.051% U.

The study indicates that the coal in the Red Desert area is of interest primarily as a fuel resource and contains only small concentrations of U. Thin carbonaceous shale interbedded with coarse-grained sandstone to the N. and E. of the principal area underlain by coal, however, may contain high-grade deposits of U.--Auth.

2-1262. Mapel, William J., and William J. Hail, Jr. TERTIARY GEOLOGY OF THE GOOSE CREEK DISTRICT, CASSIA COUNTY, IDAHO, BOX ELDER COUNTY, UTAH, AND ELKO COUNTY, NEVADA (In: U.S. Geological Survey. Uranium in Coal in the Western United States: Its: Bull. 1055, p. 217-254, 2 maps, diag., 3 charts, 5 pls. (3 under separate cover), 6 tables, 1959) 22 refs.

The Goose Creek district is an area of about 260 sq. mi. in the northern and central parts of an intermontane basin in southern Idaho and adjacent parts of Utah and Nevada and is drained by Goose Creek, a large perennial tributary of the Snake River. Tertiary rocks exposed in the district include the Payette(?) formation, of Miocene or Pliocene age, and the overlying Salt Lake formation, of Pliocene age. The Payette(?) formation is at least 900 ft. thick and consists mainly of greenish-gray shale and white volcanic ash. The Salt Lake formation is at least 2,300 ft. thick and consists largely of volcanic ash and welded rhyolitic tuff. Both formations contain thin beds of carbonaceous shale and lignite, and at various stratigraphic levels there are numerous beds of sandstone and conglomerate derived from the disintegration and erosion of older rocks exposed on adjacent highlands. The Tertiary sedimentary rocks rest unconformably on a large body of Tertiary(?) rhyolite exposed in the mountains bordering the district on th SE., and on a thick undifferentiated sequence of Carboniferous and older rocks, limestone, quartzite, and shale, exposed in the mountains to the W. and NE. Quaternary deposits of gravel, slope wash, alluvium, and landslide material overlie the older rocks locally.

The Payette(?) and Salt Lake formations are tilted in a general easterly direction, with an average dip of about 3°. Shallow folds and structural terraces modify the eastward tilting, particularly along the eastern margin of the district, where dips in the Tertiary rocks locally are reversed. Normal faults with displacements ranging from a few feet to as much as 900 ft. cut the Tertiary sequence at various places. Most of the faults trend northward or northeastward, and some may be traced for several miles.

Lignite has been mined for local use from both the Payette and Salt Lake formations, but most of the lignite has a large content of ash and is of little commercial value. Concentrations of as much as 0.1% U occur locally in lignite and carbonaceous shale in the lower part of the Salt Lake formation. Most of the U-rich beds are on the flanks and in the trough of a shallow syncline in T.16S., R.21E., Idaho. Other mineral resources include building stone and bentonite.--Auth.

2-1263. Vine, James D. GEOLOGY AND URANIUM DEPOSITS IN CARBONACEOUS ROCKS OF THE FALL CREEK AREA, BONNEVILLE COUNTY, IDAHO (In: U.S. Geological Survey. Uranium in Coal in the Western United States: Its: Bull. 1055, p. 255-294, 2 maps, chart, 2 secs., graph, 2 pls. (under separate cover) 8 tables, 1959) 9 refs.

U occurs in carbonaceous rocks of the Bear River formation, of Early Cretaceous age, in the Fall Creek area, Bonneville County. The principal deposit is at the Fall Creek coal prospect in sec. 4, T.1S., R.42E., where impure coal contains an average of about 0.02% U. Geologic mapping and sampling have demonstrated that the zone of U-bearing rocks is widespread in the area and is repeated in outcrop several times, owing to folding and faulting of the enclosing strata, although exposures suitable for sampling and analysis are few. Analytic data suggest a possible geochemical relation between U, Ge, and Mo. Four general hypotheses are advanced for the origin of U in carbonaceous rocks, but comparison of the deposits with other occurrences of U-bearing carbonaceous rocks suggests that an epigenetic hypothesis of deposition by downward percolating meteoric water seems best able to explain the occurrence of U in the Fall Creek area. Core drilling was inconclusive in demonstrating the areal extent of the radioactive units. Most of the holes did not reach the U-bearing strata, because the area is one of structural complexity, with faulting, thinning of incompetent strata, and increasingly steep dips at depth.

About 6 1/2 million tons of coaly shale, carbonaceous shale, and carbonaceous limestone with an average grade of about 0.02% U is believed to be in the area. This estimate is based on the average thickness and grade of U-bearing strata exposed in the Fall Creek coal prospect, by drill-hole data, and by the inferred extent of these strata over an area of slightly more than 400 acres.--Auth.

2-1264. Bachman, George O., James D. Vine, Charles B. Read, and George W. Moore. URANIUM-BEARING COAL AND CARBONACEOUS SHALE IN THE LA VENTANA MESA AREA, SANDOVAL COUNTY, NEW MEXICO (In: U.S. Geological Survey. Uranium in Coal in the Western United States: Its: Bull. 1055, p. 295-307, sec., chart, 7 pls. (3 under separate cover), 3 tables, 1959) 8 refs.

U-bearing coal, carbonaceous shale, and carbonaceous sandstone of Late Cretaceous age occur on and adjacent to La Ventana Mesa. The U is present in 3 lenticular beds forming a mineralized zone several feet thick at the base of the La Ventana tongue of the Cliff House sandstone. An epigenetic origin for the U from ground-water solutions that ultimately derived the U from the Pleistocene Bandelier rhyolite tuff of Smith is suggested. The content of U in the coal is as much as 0.62%, and in the coal ash is as much as 1.34%. It is estimated that 132,000 tons of coal and carbonaceous shale containing an average of 0.10% U are present on La Ventana Mesa.--Auth.

2-1265. Bieler, Barrie H., and Harold D. Wright. PRIMARY MINERALIZATION OF URANIUM-BEARING "SILICEOUS REEF" VEINS IN THE BOULDER BATHOLITH, MONTANA: PART II - THE VEINS: Econ. Geology, v. 55, no. 2, p. 363-382, 10 illus., chart, 3 diags., table, March-Apr. 1960, 36 refs.

The "siliceous reef" uraniferous veins of the Boulder batholith contain, in decreasing order of abundance, finely crystallized pyrite, sphalerite, galena, uraninite, tetrahedrite, argentite, chalcopyrite, and covellite. Microcrystalline quartz comprises over 90% of the vein material; opal and barite are minor. The color of the veins varies from light gray to black due to variation in size and concentration of the microscopic grains of opaque minerals.

Microcrystalline quartz was deposited in several stages, separated by intervals of brecciation. Quartz of the later stages is generally dark gray to black. It occurs as fracture fillings in massive early microcrystalline quartz of light color, and as a cementing matrix about breccia fragments of the lighter quartz.

The U content of nearly 100 vein samples was determined by alpha counting and fluorimetry. Radioactive equilibrium of the U series is indicated by agreement between measured Ra content (analyzed by New Brunswick Laboratory, AEC) and that required for equilibrium, with U determined in 2 samples, and by general agreement between fluorimetric and alpha-activity determinations of U. Semiquantitative spectrographic analysis of the same samples provided data on the content and distribution of 28 minor elements in the veins. In most cases, the darker the vein quartz, the higher is the content of those elements generally occurring in opaque vein minerals: Ag, As, Ba, Co, Cu, Fe, Mn, Mo, Ni, Pb, Sb, Sn, U and Zn. Elements that showed no significant correlation with vein color are Al, B, Be, Ca, Cr, Cs, Ga, Mg, Na, P, Sr, Ti, V, and Zr. Five elements - Fe, As, Co, Mo, and Pb - showed a marked positive correlation with U.--Auth.

2-1266. Lewis, Richard Q., Sr., and Donald E. Trimble. GEOLOGY AND URANIUM DEPOSITS OF MONUMENT VALLEY, SAN JUAN COUNTY, UTAH: U.S. Geol. Survey, Bull. 1087-D, p. 105-131, 2 illus., 6 maps (2 in pocket), sec., diag., 3 tables, 1959, 34 refs.

Exposed consolidated sedimentary rocks in the Monument Valley area, Utah, range from Permian to Jurassic in age and attain an aggregate thickness of more than 3,000 ft. As all the U-V deposits in the area are restricted to the Shinarump member of the Chinle formation of Late Triassic age, this study was principally concerned with that unit.

The contact between the Shinarump member of the Chinle formation and the underlying Moenkopi formation is marked by a number of deep scour channels cut into the Moenkopi and filled with sandstone and conglomerate of the Shinarump. All the U-V ore deposits are restricted to the lower channel sediments of the Shinarump. All channels are considered worthwhile areas for prospecting.

The ore deposits are small tabular to lenticular bodies that range from a few inches to 10 ft. in thickness and are commonly less than 20 ft. in width. The ore minerals replace the cementing material in the sandstone and coat fractures, joints, and bedding planes. The common U ore mineral is tyuyamunite. Uranophane, autunite, and uraninite are also present in important quantities. The common V mineral is corvusite; navajoite and hewettite are found in lesser amounts. The deposits are zoned both laterally and vertically, with the higher grade V ore generally below and downdip from the U. In general the deposits are oxidized or partly oxidized. Most of the ore is the yellow hydrous uranium vanadate: however, quantities of black unoxidized ore, containing uraninite and V minerals with an intermediate valence are found in the deeper parts of some deposits.

Good guides to ore within channel sediments are high radioactivity, U, V, and Cu minerals, and fluorescent silica, commonly hyalite.--Auth.

2-1267. Vine, James D., and George E. Prichard. GEOLOGY AND URANIUM OCCURRENCES IN THE MILLER HILL AREA, CARBON COUNTY, WYOMING: U.S. Geol. Survey, Bull. 1074-F, p. 201-239, 9 illus., 7 maps (3 in pocket incl. geol. map, scale 1:48,000), 3 secs., 5 tables, 1959, 23 refs.

U occurs in the North Park(?) formation of Pliocene(?) age in the Miller Hill area, about 25 mi. S. of Rawlins, Wyoming. The North Park(?) formation in the Miller Hill area is at least 800 ft. thick and unconformably overlies all older rocks. It consists principally of water-worked fine-grained pyroclastic debris and detrital mineral grains and includes several fresh-water limestone beds.

Beds of brecciated silicified limestone 3 to 10 ft. thick contain the principal concentrations of U. Lesser concentrations are found in calcareous sandstone and quartzite. Uranophane, $Ca(UO_2)_2Si_2O_7 \cdot 6H_2O$, the principal U mineral, has been deposited in vugs as fracture and surface coatings, and as a disseminated constituent of the rock. U also occurs in quantities too small to be megascopically visible in dark-colored beds of chalcedony, limestone, and quartzite.

The U deposits in the Miller Hill area are thought to be a secondary concentration deposited from ground-water solutions that leached disseminated U from thick porous beds of tuffaceous sandstone in the North Park(?) formation. It is suggested that the mechanism for deposition was the reaction of silica- and U-rich ground water upon contact with limestone. The higher grade concentrations may represent further recent surficial enrichment of U due to evaporation of capillary moisture; however, uraniferous limestone that is continuously exposed to weathering for a relatively long period of time is eventually leached.

As much as 0.5% U is contained in grab samples, but only about 1,000 tons of rock is known to contain as much as 0.03% U. Visual spectrographic analyses of 31 samples of mineralized limestone are tabulated. --Auth.

2-1268. Davidson, C. F. REJUVENATION OF PITCHBLENDE IN HERCYNIAN ORE DEPOSITS: Econ. Geology, v. 55, no. 2, p. 383-386, table, March-Apr. 1960, 23 refs.

In a majority of instances, geochronological studies on pitchblende samples from the Hercynian granites of Western Europe reveal an age much younger than that of the granite plutons. This youthfulness is attributed to rejuvenation of an initial mineralization emplaced in Hercynian times. Before the geological history of such deposits can be correctly interpreted from mineragraphic investigations, the possibility of there having been several periods of reworking must be recognized.--Auth.

2-1269. Gravenor, C. P. IRON DEPOSITS IN WESTERN CANADA: Western Miner & Oil Rev., v. 33, no. 1, p. 31-40, illus., 4 figs., 3 tables, Jan. 1960, refs.

A breakdown of potential reserves; mineralogy and geology of the major known Fe deposits in British Columbia, Alberta, Saskatchewan, and Manitoba. A great deal more exploration must be undertaken before these occurrences can be evaluated accurately. --Worldwide Oil and Gas Abstracts, v. 7, no. 2, p. 12, March-Apr. 1960, abs. 72-C8.

2-1270. Quirke, Terence T., Jr., Samuel S. Goldich, and Harold W. Krueger. COMPOSITION AND AGE OF THE TEMISCAMIE IRON-FORMATION, MISTASSINI TERRITORY, QUEBEC, CANADA: Econ. Geology, v. 55, no. 2, p. 311-326, 2 maps, 3 tables, March-Apr. 1960, 25 refs.

The Temiscamie Fe formation of the Lake Albanel iron range in Mistassini territory, Quebec, is approximately 700 ft. thick and is divided into 6 members on the basis of lithology. The principal Fe-bearing minerals are siderite, magnetite, hematite, and iron silicates. A bulk chemical analysis of the Fe formation, excluding the thin lower argillite member, shows 29% of Total Fe and is similar in many respects to the average compositions of Fe formations of the Mesabi, Cuyuna, and Gogebic districts.

The Temiscamie Fe formation is overlain by the Kallio slate and is underlain by the Boulder Bay quartzite and the upper and lower Albanel dolomites, the sequence constituting the Mistassini group. These rocks are underlain by sediments of the Papaskwasati group, which rest with angular unconformity on a basement of folded sediments and volcanics of the Sam Gunner group. The latter was earlier intruded by igneous rocks of the Takwa complex. The Papaskwasati and Mistassini sediments are relatively unmetamorphosed. They dip to the SE. and abut against high-grade metamorphic and igneous rocks of the Grenville subprovince along the Mistassini fault. The names Boulder Bay quartzite, Sam Gunner group, and Takwa complex are introduced.

The Temiscamie Fe formation, on the basis of lithology, has been correlated with the Fe formation of the Labrador trough. Results of radioactivity dating are inconclusive but indicate the possibility of the Temiscamie Fe formation being younger than the Huronian Fe formations of the Lake Superior district. At the same time the radioactivity dates from northern Quebec and Labrador suggest a complicated geologic history for this region. Effects of the Grenville orogeny have been superimposed on rocks that were involved in 2 earlier major orogenies.--Auth.

2-1271. Gielicz, Ludwik. OLENEGORSK IRON-ORE CONCENTRATES. Prepared by U.S. Joint Publications Research Service: Internat. Geology Rev., v. 2, no. 2, p. 134-137, 2 tables, Feb. 1960, ref.

This report describes the processing of Fe-bearing quartzites mined at Olenegorsk and shipped to sintering plants in Poland. Projected annual productive capacity of concentrates is 1,600,000 tons. Explored reserves are estimated at 333,000,000 tons. --M. Russell.

2-1272. Ting, P'ei-chen. A PRELIMINARY STUDY OF THE MAGNETITE DEPOSIT AT CHIEN-P'ING, HOPEI PROVINCE. Translated by Royer and Roger: Internat. Geology Rev., v. 2, no. 1, p. 1-7, 6 illus., map, 2 secs., diag., Jan. 1960.

The magnetite Fe ores of Chien-p'ing, Hopei, China, occur in hornblende-plagioclase granulite and impure marble of the Archean Sang-kan system. The stratigraphic sequence of the region includes Archean, Proterozoic Sinian system, Cambrian, Ordovician, and Quaternary deposits. The ores are deep-seated, high-grade metamorphic deposits formed partly by hydrothermal action. Significant minerals of the ores are pyroxene, hornblende, magnetite, and brucite.--M. Russell.

2-1273. Sorem, Ronald K., and Eugene N. Cameron. MANGANESE OXIDES AND ASSOCIATED MINERALS OF THE NSUTA MANGANESE DEPOSITS, GHANA, WEST AFRICA: Econ. Geology, v. 55, no. 2, p. 278-310, 21 illus., 2 charts, 4 tables, March-Apr. 1960, 28 refs.

Mineragraphic and X-ray investigations of Mn ore from the highly productive deposits of Nsuta, Ghana, indicate that the principal manganese oxide minerals, in order of decreasing abundance, are Nsuta MnO_2, cryptomelane, pyrolusite, and lithiophorite. Goethite is closely associated with manganese oxides in some of the ore. Nonmetallic impurities identified are muscovite, quartz, garnet, zircon, and amphibole.

X-ray diffraction data indicate that Nsuta MnO_2 is a discrete mineral or mineral group, with no direct relation to pyrolusite or ramsdellite. Powder patterns given by Nsuta MnO_2 also differ from those reported for the artificial manganese dioxide gamma-MnO_2. One type of Nsuta MnO_2 gives a pattern closely resembling that of rho-MnO_2, a chemical product, but the d spacings and relative intensities of certain lines are not identical.

Oxide-rich ore was formed by 3 principal mechanisms: replacement of rocks rich in quartz, muscovite, garnet, and perhaps other minerals; filling of fractures and other openings; and leaching of impurities from low-grade ore with or without addition of manganese oxides. The 3 types of ore are intimately related and consist predominantly of Nsuta MnO_2 and cryptomelane. Pyrolusite and lithiophorite are abundant, however, in certain specimens of replacement ore and cavity-filling ore. Goethite is resent locally in all 3 types of ore.

Nsuta MnO_2 and cryptomelane are early minerals n most specimens, but there is no fixed paragenetic equence of the oxide minerals. Two or more genertions of various oxides are present in many specimens.

The mineral assemblage of the ores, the paraenetic sequence, and the textures and structures ll appear to be consistent with supergene deposition f the manganese oxides. The origin of a mineral eposit can seldom be determined solely by laboraory study, but certainly these ores are of a kind hat would be expected if meteoric water, varying ntermittently in supply and composition, were the rincipal agent of oxide formation.--Auth.

-1274. Gillson, Joseph L., and others, eds. NDUSTRIAL MINERALS AND ROCKS: 3d ed. rev., 34 p., illus., port., maps, diags., graphs, tables, ew York, American Institute of Mining, Metallurgial, and Petroleum Engineers, 1960, refs.

This is an enlarged and completely rewritten ediion of a volume published in 1937 and revised in 949. Fifty-six separate chapters, written by authories, cover all the important commercial nonmetalics: abrasives, asbestos, Ba minerals, bauxite, entonite, bleaching clay, borax and borates, carbonte rocks, cement materials, chalk and whiting, hromite, clay, crushed stone, diatomite, dimension tone, feldspar, nepheline, syenite, and aplite, fluorpar and cryolite, gem stones and allied materials, ranules, graphite, gypsum, lightweight aggregates, me, Li ores, magnesite and related minerals, Mn re, mica, mineral fillers, mineral pigments, minral wool, minor minerals, monazite and related inerals, native bitumens, N compounds, phosphate ock, potash, pyrophyllite, quartz crystal and optical alcite, refractories, salt, sand and gravel, secondry fertilizer materials, silica sand and pebbles, the illimanite group, slate, natural sodium carbonate nd sulfate, Sr minerals, S and pyrites, talc and oapstone, Ti, tripoli, vermiculite, wollastonite, nd Zr and Hf minerals.

In general, the treatment of each subject covers ne classification, types, composition, and properties f the mineral; its mode of occurrence and distribuion, both domestic and foreign; the geology and geohemistry of the deposits; mining and preparation or market; markets; price, production, and conumption data through 1958; tests and specifications; ses.--E. H. Robie.

-1275. Gabrielse, Hubert. THE GENESIS OF HRYSOTILE ASBESTOS IN THE CASSIAR ASBESOS DEPOSIT, NORTHERN BRITISH COLUMBIA: con. Geology, v. 55, no. 2, p. 327-337, 6 illus., maps, table, March-Apr. 1960, 6 refs.

A comparison of the Cassiar asbestos serpentinite ody with other ultramafic bodies in the McDame maprea of northern British Columbia suggests that the ritical conditions leading to ore deposition at Casiar were as follows: 1) pervasive serpentinization f an ultramafic body resulting in mesh-structure erpentine, serpophite and bastite; 2) development f abundant fractures in the serpentinite body; 3) rerystallization of the serpentinite during low-grade etamorphism, perhaps equivalent to the upper part f the green-schist facies.

Rocks of the area were probably folded while the earby Cassiar granitic rocks were emplaced. This eformation produced a complex system of fractures in the serpentinite body. In a low-grade, contact-metamorphic environment asbestos-forming material diffused into fractures of low rock pressure and crystallized to form chrysotile-asbestos veins.--Auth.

2-1276. Bichan, W. James. COMMERCIAL CHRYSOTILE DEPOSITS, BAIE VERTE, NOTRE DAME BAY DISTRICT, NEWFOUNDLAND - PRELIMINARY NOTES: Econ. Geology, v. 55, no. 2, p. 399-401, sec., March-Apr. 1960.

Deposits of chrysotile and picrolite, forming flat, tabular zones within a mass of tightly folded, block-faulted peridotite and serpentinite, are summarily described. The deposits, owned by Advocate Mines Limited, contain an estimated 30 million tons open-pit ore worth at least $250,000,000.--J. A. Chamberlain.

2-1277. Withington, Charles F., and Marion C. Jaster. SELECTED ANNOTATED BIBLIOGRAPHY OF GYPSUM AND ANHYDRITE IN THE UNITED STATES AND PUERTO RICO: U.S. Geol. Survey, Bull. 1105, 126 p., 1960.

This bibliography contains more than 400 annotated references that are concerned with the geologic occurrence of gypsum and anhydrite in the United States; the description of specific deposits; the mining, processing, and uses of gypsum and anhydrite; and the origin and properties of the calcium sulfate minerals. The annotations are arranged alphabetically by author. The data in the annotations are indexed according to geographic area and subject.--Auth.

2-1278. McGrain, Preston. SERVICES OF STATE GEOLOGICAL SURVEYS TO THE STRUCTURAL CLAY PRODUCTS INDUSTRY: Am. Ceramic Soc., Bull., v. 38, no. 8, p. 415-417, illus., map, Aug. 1959, 9 refs.; reprinted as: Kentucky Geol. Survey, Reprint 3, Ser. 10, 1959.

The structural clay products industry has benefited directly and indirectly from investigations of state geological surveys for years. Routine areal geologic mapping, begun in this country more than 100 years ago, has delineated many clay- and shale-bearing horizons. More recently systematic sampling and testing of clays and shales has been conducted in many states. The tests include P. C. E. determinations and the making and firing of standard briquettes to ascertain color, green and fired strength, hardness, shrinkage, absorption, and drying characteristics. In some state geological survey laboratories clay-mineral determinations by X-ray diffraction, chemical, spectrochemical, and differential thermal analysis supplement the firing data. Case histories, in which structural clay plants have benefited from such investigations, are cited.--Auth.

2-1279. Plummer, Norman, Maynard P. Bauleke, and William B. Hladik. DAKOTA FORMATION REFRACTORY CLAYS AND SILTS IN KANSAS: Kansas, State Geol. Survey, Bull. 142, pt. 1, p. 1-52, 9 illus., map, chart, diag., 4 graphs, 1960, 18 refs.

Routine ceramic testing (supplemented by chemical analysis and hot load testing) of samples of refractory clay and silt from the Dakota formation [Cretaceous] from 25 locations in Kansas showed that some of the clays can be formed into a good grade of semi-silica refractory brick. The brick exhibits excellent volume stability and hot-load-carrying characteristics at temperatures as high as 2,500°F. --Auth.

2-1280. Currier, L. W. GEOLOGIC APPRAISAL OF DIMENSION-STONE DEPOSITS: U. S. Geol. Survey, Bull. 1109, 78 p., 8 illus., map (in pocket), 2 graphs, 4 tables, 1960, 32 refs.

The construction stone industry comprises 2 major branches - dimension stone, and crushed and broken stone. For purposes of geologic appraisal, deposits of these 2 categories should be treated separately because they differ widely in use, mode of development, and exploitation. Deposits of dimension stones are subjected to much greater selectivity with respect to physical properties, uniformity, and modes of occurrence; these demand a much more critical and detailed study of geologic and mineralogic features.

Dimension stones are classified commercially in 7 principal varieties - granite, limestone, marble, sandstone, slate, greenstone, and basalt; commercial definitions of these are much broader and more inclusive than are the petrographic definitions. Each type presents certain distinctive aspects of occurrence and properties as related to geologic features. Dimension stones except slate are classified further, for statistical purposes, according to use as building, monumental, paving blocks, curbing, and flagging. Building stone constitutes about 80% (quantity) of dimension stone produced and monumental stone about 10%. The general level of production since World War II is about half that of recorded earlier peak productions, a decline that reflects, in part, changes in construction practice for large buildings and, in part, substitution of manufactured materials.

The appraisal of deposits of dimension stones involves factors that are, in part, peculiar to the economy of the industry, but in large part are of a geologic and mineralogic nature. The suitability of a deposit for development is dependent in large measure upon major geologic structural features; the durability of the quarry product is determined by physical and chemical properties which, in turn, are functions of mineralogic composition, and textural and certain minor structural features. The acquiring and interpretation of pertinent geologic and mineralogic data fall within the appropriate functions of the field geologist. This paper outlines and discusses the relevancy of such data to geologic appraisal.--Auth.

2-1281. Quebec (Province), Dept. of Mines. THE MINING INDUSTRY OF THE PROVINCE OF QUEBEC IN 1958: 136 p., 8 illus., graph, 65 tables, Quebec, Queen's Printer, 1959.

In 1958, the value of the mineral production of Quebec was $389,442,985. This amount is $54,365,995, or 12%, less than the total of $443,808,980 obtained in 1957.

The economic recession of 1957-1958 affected mostly the metal producers as a group. Sales of Fe and Fe ore declined the most. Operators of Pb and Zn mines saw their difficulties compounded by the imposition of import quotas by the United States government.

In the industrial minerals group, asbestos and titanium dioxide brought $14,744,824 less than they did in 1957. This amount represents 91% of the $16,233,490 loss suffered by the group as a whole.

However, the combined value of the building materials, $84,933,871, is only 0.1% below the all-time record of $85,029,476 attained in 1957.--E. E. Bérubé

The report deals in turn with metallic substances, nonmetallic minerals, development and mining operations in the province, and employment, wages, and accidents in mines and quarries in 1958. The report for 1957 was listed as GeoScience Abstracts 1-762.

2-1282. Quebec (Province), Dept. of Mines. OUTLINE OF PROGRESS OF THE MINING INDUSTRY IN THE PROVINCE OF QUEBEC DURING THE YEAR 1959, by Edgar E. Bérubé: 29 p., 4 illus., 2 tables, Quebec, Queen's Printer, 1960.

Preliminary statistics of the Dept. of Mines establish the total value of the mineral production of the province in 1959 at $461,979,700, a gain of $72,536,715 over 1958 (for 1958 report see GeoScience Abstracts 1-1550). Metallics, nonmetallics, and building materials all showed substantial gain over 1958 figures. Tables show comparative figures for 1958 and 1959 for 34 substances. Of these, 15 registered a gain in value, the most important substances being Fe ore, Cu, asbestos, Fe, and titanium oxide. The most noteworthy gain was recorded for Fe ore, despite a steel strike in the United States which slowed down ore shipments.

The province has been divided into 6 distinct mining districts: 1) New Quebec and North Shore district; 2) Chibougamau district; 3) Val d'Or district; 4) Rouyn-Noranda district; 5) Montreal-Quebec district (N. of the St. Lawrence River); 6) district S. of the St. Lawrence, including the Eastern Townships and Gaspé Peninsula. Exploration and development in each of these districts is described in turn. In the New Quebec and North Shore district, the exploration, development, and mining operations undertaken surpassed in scope and in capital investments any other single project undertaken elsewhere in the province.--A. C. Sangree.

2-1283. McKinstry, Hugh E. THE FUTURE OF MINING IN COLORADO...SOME GEOLOGICAL AND ECONOMIC ASPECTS: 28 p., port., 4 tables, Denver, Mining and Petroleum Committee, Colorado State Chamber of Commerce, [1960?], 10 refs.

Although the ultimate productivity of a mining area depends on ore reserves, it is shown that for any given large mineral area the rate of development, exploration, and overall production, depends primarily on prices, tax structure, and political climate. Mineral areas which have prospered, such as Canada and South Africa, are compared to those which have suffered, as for example Mexico. Geologically, the probability is that Colorado has enormous reserves of minerals, but an economic incentive in the form of favorable tax laws and an encouraging political climate are necessary before any significant expansion of the mining industry can be expected. The establishment of a severance tax on mineral production is particularly to be discouraged.--M. Russell.

2-1284. Miller, Robert H. MINERAL RESOURCES OF SOUTH DAKOTA: 96 p., 20 illus., 2 maps, 14 graphs, tables, Pierre, South Dakota, Industrial Development Expansion Agency, Feb. 1959, 24 refs.

A description of the physical characteristics, uses, facilities for production, geologic and areal occurrence, and production by value and volume 1940-1958 is given for most of the following minerals and mineral products of South Dakota: bentonite, beryl, cement, clays, Nb-Ta, Cu, Pb, Zn, feldspar, Au, Ag, granite, gypsum, Fe ore, lignite, lime, limestone, Li, Mn, mica, petroleum, natural gas, quartzite, sand and gravel, U, W, Sn, semiprecious gems, and volcanic ash.--M. Russell.

2-1285. Turneaure, Frederick S. **A COMPARATIVE STUDY OF MAJOR ORE DEPOSITS OF CENTRAL BOLIVIA. PART I:** Econ. Geology, v. 55, no. 2, p. 217-254, 15 maps, 3 secs., 3 graphs, 8 tables, March-Apr. 1960.

The present article describes 5 major ore deposits of the eastern Andes of central Bolivia, the Sn deposits of Llallagua, Huanuni, and Morococala, and the Sn-Ag deposits of Potosi and Oruro. The deposits at Potosi, Llallagua, and Oruro are associated with porphyry intrusions of middle (?) Tertiary age, whereas the veins of Huanuni and Morococala occur in altered sedimentary rocks. In the Llallagua-Oruro region, the Paleozoic sedimentary formations of northwesterly trend are cut by numerous transverse faults, many of which seem to be related to the early folding. Two longitudinal faults of the strike-slip type at Llallagua belong to a late period of deformation.

The ore deposits are all of the multiple vein type. The simpler vein patterns correlate with regional stress, but those of greater complexity are probably the result of combined regional and local stress. Narrow veins and stringer lodes account for most of the ore, but some sheeted zones, stockworks and breccia lenses have been productive.

Mineralization was long continued, and hydrothermal alteration largely preceded vein filling. Chlorite, sericite, and quartz are characteristic of both the Sn and Sn-Ag deposits; tourmaline occurs with the Sn ores. Minerals typical of the Sn veins are quartz, cassiterite, bismuthinite, pyrrhotite, stannite, marcasite, pyrite, siderite, and minor teallite or franckeite. The Sn-Ag ores contain cassiterite, pyrite, stannite, sulfosalts of Pb and Ag, alunite, and kaolinite. Many other minerals occur in lesser amounts.

An unusual temperature range is indicated; maximum temperatures of 400°to 500°C. were probably reached during the early stages of mineralization, the temperature decreasing to 100°C. as mineralization came to a close. Early deposition took place in a neutral to slightly alkaline environment, but the vein mineralogy suggests that the solutions became slightly acid during the late stages of vein growth. Cassiterite is associated with pyrrhotite in the Sn ores but with pyrite in the Sn-Ag ores, a contrast that may be related to the S concentration of the ore fluid.

The ore deposits were formed in the near-surface, volcanic environment, characterized by extreme changes in temperature and pressure. Rapid drop in pressure as well as in temperature may have been a factor in the change from silica deposition to silica leaching during hydrothermal alteration, in the formation of bonanza ore shoots, and in the development of ore fluids of acid reaction. Combining the features of high temperature and shallow depth, the deposits exemplify the xenothermal type. The degree of telescoping is perhaps greater in the Sn ores than in the Sn-Ag ores.--Auth.

13. FUELS

See also: Geologic Maps 2-1040, 2-1044, 2-1046; Areal and Regional Geology 2-1050, 2-1052, 2-1059, 2-1061, 2-1062, 2-1064 through 2-1068, 2-1085, 2-1087, 2-1088, 2-1092, 2-1107; Structural Geology 2-1124; Geochemistry 2-1223; Mineral Deposits 2-1241.

2-1286. Amyx, James W., Daniel Materson Bass, Jr., and Robert L. Whiting. **PETROLEUM RESERVOIR ENGINEERING - PHYSICAL PROPERTIES:** 610 p., 353 figs. (incl. approx. 35 work charts), New York, McGraw-Hill Book Company, 1960, approx. 200 refs.

The first volume of a 2-volume work on reservoir engineering, this book develops the fundamentals of rock and fluid properties on which reservoir engineering is based. Methods of data evaluation for reservoir engineering purposes are included, together with applications of rock and fluid properties for determination of oil and gas in place.

The book is comprised of 8 chapters including an introductory chapter. The 2 chapters on rock properties develop systematically the concepts of porosity, permeability, electrical properties, relative permeability, and capillary pressure. The correlation and application of such data are presented in the chapter on data evaluation. Properties of petroleum reservoir fluids, oil, gas, and water are discussed in 3 chapters. Numerous work charts are presented. Emphasis is placed on determination of appropriate properties for reservoir fluids. An extensive treatment of composite volume factors is presented. The chapter on data evaluation presents information on preparation of field and laboratory data for reservoir calculations. Production, well tests, and pressure tests are discussed. Methods of averaging fluid and rock properties are presented and are applied to the volumetric determination of oil or gas in place. In the final chapter, the material balance is derived in general form, and the many specialized forms are obtained therefrom. Examples of determination of oil or gas in place from pressure-production data are presented.

About 80 example problems covering rock and fluid properties, data evaluation and material balance calculations are included.--Auth.

2-1287. Frederickson, A. F., and R. C. Reynolds, Jr. **HOW MEASURING PALEOSALINITY AIDS EXPLORATION:** Oil & Gas Jour., v. 58, no. 5, p. 154-155, 157-158, chart, 4 diags., 2 tables, Feb. 1, 1960, 6 refs.

Illites extract B from sea water in proportion to the amount present. The B is strongly fixed into the illite lattice and is not expected to be substantially changed by normal geological processes. The B content of sea water bore a linear relationship to salinity of the water over the range tested, which included the surf zone, shallow bays, euxinic bayous, and evaporating tidal flats. Relative salinities of the seas at the time of formation of sediments can be evaluated from the B content of illites extracted from them.--N. Street.

2-1288. Keith, James W. **NEW TECHNIQUE FOR USE IN CARBONATE CORE EXAMINATION:** Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 2,

p. 254-255, Feb. 1960.

An extremely simple, fast, and inexpensive solution to the problem of examining cores coated with a tough layer of drilling "mylonite" is to sand a strip along the outside of the core. This can be done with a small hand electric drill with a rotary sanding disc attachment. Contacts, fossil content, texture, orientation, etc., can be easily studied, saving the expense of slabbing the core.--I. M. Johnston.

2-1289. DeBlois, Roland, comp. DATA ON WELLS DRILLED FOR GAS AND PETROLEUM IN THE ST. LAWRENCE LOWLANDS AREA: Quebec, Dept. Mines, S-49, 160 p., fold. map, scale 1 in. to approx. 6 mi., 1959.

Contains principal data on most of the wells drilled to the end of 1958. For each well the following information is given: name of company; name of well; location; elevation; beginning and completion dates; drillers; type of rig; results; depths and yields of any water, gas, and petroleum encountered; geological log of formations penetrated. Map shows location of all wells mentioned in the report.--A. C. Sangree.

2-1290. Stevens, Curtis, and Don Stevens, comp. and ed. HUGOTON EMBAYMENT-ANADARKO BASIN HANDBOOK; A COMPENDIUM OF OIL AND GAS FIELD INFORMATION ON THE AMARILLO-HUGOTON AREA: 412 p., approx. 150 geol. structure maps, isopachs, cross secs., Amarillo, Texas, National Petroleum Bibliography, 1960, approx. 550 refs.

The first comprehensive study of oil and gas fields over the entire Amarillo-Hugoton area, 60,000 sq. mi. in the Texas and Oklahoma Panhandles, SW. Kansas, SE. Colorado, and NE. New Mexico. Activity to Jan. 1, 1960, is covered. The book opens with a descriptive summary of past, present, and future activity over the region. Other sections are as follows: map of geologic features; representative formation correlation chart; chart of producing horizons; directory of information sources on the area; directory of operators drilling deep-zone wells during 1959; geographic classification of operators drilling deep-zone wells during 1959; directory of consulting geologists and engineers located in the area in 1959; bibliography of literature and technical data on Amarillo-Hugoton; alphabetical classification of some 700 oil and gas fields, including for each field, information on location, discovery well, field data, production outlet, productive wells; index of fields by county and discovery well.--A. C. Sangree.

2-1291. Kuhn, Paul J., comp. and ed. DELAWARE BASIN OIL: 152 p., illus., 65 maps, 16 secs., log, San Angelo, Texas, Petroleum News Co., 1959.

A reference volume on the Delaware basin of W. Texas and SE. New Mexico. Three articles are included: Resume of Delaware Basin Geology (p. 3-11); Oil Traps in the Delaware Basin, by C. F. Dodge (p. 12-19); and Seismic Work in the Delaware (p. 21-23). Counties included in the Delaware basin are : Eddy and Lea counties in New Mexico, and Culberson, Loving, Pecos, Reeves, Ward, and Winkler counties in Texas. Production is from rocks of Permian age.

In the field data section (p. 25-152), the following information is given for the 92 different oil fields in the basin: location; product (oil or gas); discovery data which includes discovery well, exploration method, initial production, producing zone, depth to top of pay zone, and total depth; geological notes, including type of structure, proven area, producing horizon, elevation of structure from a given datum plane, deepest test, and gravity of oil; and finally, development-production which includes owner, GOR (gas-to-oil ratio) limit, well spacing, and cumulative production.--M. Russell.

2-1292. Cashion, William B. GEOLOGY AND OIL-SHALE RESOURCES OF NAVAL OIL-SHALE RESERVE NO. 2, UINTAH AND CARBON COUNTIES, UTAH: U.S. Geol. Survey, Bull. 1072-0, p. 753-793, 10 maps (col. geol. map in pocket, scale 1:48,000), 2 secs. (in pocket), logs (in pocket), 4 tables, 1959, 8 refs.

Naval Oil-Shale Reserve No. 2 occupies an area of about 140 sq. mi. on the S. flank of the Uinta basin in northeastern Utah. The area is characterized by flat-topped uplands and steep-walled canyons, with maximum relief in Desolation Canyon along Green River near the western boundary.

The rocks exposed are mainly sandstone, shale, and marlstone which were deposited near the souther margin of a great inland basin during the Eocene epoch of the Tertiary period. The coarse-grained sediments were deposited in a fluvial environment, and the fine-grained sediments in a lacustrine environment. The fluvial rocks comprise a lower formation, the Wasatch, and an upper formation, the Uinta, which are separated by the lacustrine rocks of the Green River formation.

The Green River formation is about 3,500 ft. thick and includes most of the rocks exposed in the area. Three members of the Green River formation were mapped in the area. These are, in ascending order, the Douglas Creek, Parachute Creek, and Evacuation Creek members. The Douglas Creek member is a predominantly sandy unit with some interfingering fine-grained beds. The Parachute Creek member, which contains the principal oil-shale beds of the Green River formation, is composed mainly of marlstone and siltstone. The Evacuation Creek member is composed of marlstone and siltstone with numerous beds of sandstone in the upper 220 ft.

Only the basal part of the Uinta formation is exposed in the reserve. It is predominantly fluvial sandstone and siltstone.

The structure of most of the mapped area is a northward-dipping homocline. This homoclinal structure is broken in the southwestern part of the area by the eastern end of an eastward-plunging anticline and a small syncline. Most of the faulting is restricted to the vicinity of 2 parallel grabens, 12 mi. apart, in the northeastern and southwestern parts of the mapped area. The Green River formation is cut by 2 well-developed vertical joint systems, one trending NE. and the other NW.

There are 2 oil-shale zones of possible economic importance in Naval Oil-Shale Reserve No. 2. Both zones attain their maximum thickness and richness in the northeastern part of the area, and both zones decrease in thickness and richness to the SW. In an area of about 113 sq. mi., shale in a continuous sequence 15 ft. or more thick that will yield an average of 15 gallons of oil per ton is estimated to contain 3.8 billion barrels of oil. In an area of less than 1 sq. mi. in the northwestern part of the reserve the oil shale is considered potentially strippable.

Several wells drilled a few miles W. of Naval Oil-Shale Reserve No. 2 found oil and gas in the Green River-Wasatch contact zone and in a lower zone within the Wasatch formation. Rocks at these horizons in the reserve should be similar lithologically. Production of oil and gas from strata of Mesozoic age elsewhere on the S. flank of the Uinta basin indicates that accumulations of oil and gas may be present in the strata of Mesozoic age underlying Naval Oil-Shale Reserve No. 2.--Auth.

2-1293. **Gil, Roberto Gutierres. ISTHMUS OF TEHUANTEPEC. Translated by Lauro A. Yzaguirre: Oil & Gas Jour., v. 58, no. 7, p. 159-160, 162-163, Feb. 15, 1960; no. 8, p. 150, 152-153, 155, 158, 160-161, Feb. 22, 1960, 6 maps, 5 secs., table.**

In 2 parts. Pt. 2 is entitled "Tehuantepec Oil Domes May Mark Potential Oil Territory For Mexico."

The oil-producing area called the southern zone is located in the northern part of the Isthmus of Tehuantepec. The Saline basin extends from the southeastern part of the state of Veracruz to the central part of the state of Tabasco; the oil produced is associated with salt dome traps. Structures in the Macuspana basin may be due in part to the Sierra Madre orogeny and in part to deep salt domes. The oil-bearing formations of the Macuspana and Saline basins are mainly Miocene. The various formations of the basins are described.

The Saline basin is limited on the S. by the Sierra Madre anticlinorium, on the E. by the San Andres massif, to the NW. possibly by the northern Chiapas anticlinorium and is as yet unlimited to the N. In many wells the salt in the area is pre-Upper Cretaceous and on the Chinameca dome pre-Upper Jurassic. It may be contemporaneous with red beds of not precisely defined age but which have been observed unconformably overlying middle Permian. Permian seas probably covered the Isthmus. At the end of the Permian or during the Triassic the area was rapidly uplifted and the red beds derived from the uplifted area. Salt was formed from evaporation of seas during Triassic and Jurassic. The entire basin area subsided at the beginning of the Upper Cretaceous, and shales and sandstones were deposited. A well-defined basin was formed at the end of this period. Subsidence occurred in the Eocene, with some uplift in middle Eocene, followed by continued subsidence during the Oligocene while at the same time the domes grew. During middle Miocene the basin uplift began, and sediments include lacustrine and nearshore with some marine transgressions.

From 1906 to July 1959, 1,511 wells have been drilled and 32 fields discovered. The 23 fields of the Saline basin have an accumulated production of 251,368,138 bbl. of oil and the Macuspana basin 18,185,683 bbl. from 9 fields.--N. Street.

2-1294. **Mackowsky, M. Th. RESULTS OF COKE MICROSCOPY WITH THE AID OF VARIOUS RESEARCH METHODS. Translated by Gilbert H. Cady: Internat. Geology Rev., v. 2, no. 1, p. 68-81, 21 illus., 3 charts, 8 diags., 3 tables, Jan. 1960, 8 refs.**

The measurement of coke structure developed by E. Hoffmann and F. L. Kuhlwein is critically considered, and the characteristics of a homogeneous coke and the lack of homogeneity in coke structure is investigated. Possible nonhomogeneity in coke structure may be unmelted or poorly softened grains, slime aggregates, or a strongly variable optical character. The first 2 nonhomogeneities mentioned affect hardness properties; the last affects reactivity and probably thermal loss in oven operation. Relationship between optical character of coke and its reactivity or conductivity and the relation of reactivity and conductivity are described.--Auth.

2-1295. **Klimova, L. T. ON THE BITUMINOSITY OF MESOZOIC SEDIMENTS IN THE TRANSBAIKAL REGION. Translated by Salih Faizi: Internat. Geology Rev., v. 2, no. 2, p. 156-158, Feb. 1960.**

The lithologic and stratigraphic relationships of Jurassic and Cretaceous basins of the Transbaikal region are described. Most are fresh-water deposits. Bituminous paper shales and brown coal are significant features of the Lower Cretaceous sequence. Studies made of the bituminous constituents indicate deposition under reducing conditions. Basins of the Transbaikal and Gobi are compared. Prospects for oil are poor in the Transbaikal region.--M. Russell.

14. ENGINEERING GEOLOGY

See also: Areal and Regional Geology 2-1049; Fuels 2-1286.

2-1296. **Trefethen, Joseph M. GEOLOGY FOR ENGINEERS: 2d ed., 632 p., 193 figs., 72 tables, Princeton, N.J., D. Van Nostrand, 1959, 162 refs.**

This geology text for engineering students presents first a section of 14 chapters dealing with materials - minerals and rocks. The chapter on igneous rocks is followed by one on weathering, and this in turn by a consideration of unconsolidated sediments that links geologic characteristics with some concepts of soils mechanics as a basis for subsequent engineering training in that specialty. Consolidated sediments, metamorphic rocks, structures of rocks, and earthquakes are discussed, and a summary of geological and geophysical field exploration is presented. The second part of the book deals with surface processes and their results. Chapters on the atmosphere, ground water and its related subject earth movements, streams with their related problems of dam sites and reservoirs, shorelines, and glaciers are followed by some hints on interpretation of geology from air photos and topographic maps. Appendices give sources of geologic information readily available to the engineer, the physical properties of common rocks, and tables for the determination of common minerals. An attempt is made to relate the subject matter of each chapter to engineering practice, and examples of application are introduced. The book is a text of elementary geology for engineers, not an engineering text for geologists.--Auth.

2-1297. **Austin, Carl F. LINED-CAVITY SHAPED CHARGES AND THEIR USE IN ROCK AND EARTH MATERIALS: New Mexico, Bur. Mines & Mineral Resources, Bull. 69, 80 p., 30 illus. (1 col.), 9 profiles, 9 diags., graph, 6 tables, 1959, 79 refs.**

Properly designed explosive charges with reentrant, metal-lined cavities yield high-velocity metallic jets. The firing of such jets into a metal target creates a hole through flowage of target material. Current liner-collapse theories (the hydrodynamic, plastic-flow, spherical-convergence, and brittle-fracture) are summarized.

A large number of tests were carried out in which metallic jets, derived from cast iron liners, were fired into rhyolite, altered quartz monzonite, limestone, sandstone, and rocky alluvium. Rock targets formed craters at the air-target interface owing to spalling, and at times showed deep, incipient cratering related to shock phenomena. Rocky alluvium and highly fractured, altered quartz monzonite did not yield surface craters.

Penetrations beyond the depth of cratering consisted of deep, narrow holes up to slightly over 3 ft. in depth, depending on the charge design and type of target rock.

Limestone, unlike other rock targets, showed virtually no crushing adjacent to the holes but possessed excellent radial fracture patterns. These fracture patterns offer interesting possibilities for rock-mechanics studies.

Designs and costs of charges and liners are presented, and hazards due to air blast, incandescent backblast, fumes, and normal explosives handling are discussed.

In addition to fracture studies, field applications are noted for the following situations: where drilling of holes would be hazardous, where drilling is required in inaccessible locations, where drilling time is of importance, and where only a few holes are required. In all cases, the holes desired must be shallow.--Auth.

15. MISCELLANEOUS

2-1298. Allen, Donald S., and Richard J. Ordway. PHYSICAL SCIENCE: 825 p., illus., maps, secs., diags., Princeton, New Jersey, D. Van Nostrand Company, 1960, approx. 200 refs.

This text was written for the nonscience major with little or no previous training in the sciences and no mathematical training beyond elementary algebra. It is an outgrowth of a year course in the physical sciences which has been developed at State University College of Education, New Paltz, New York, over a period of nearly 15 years. No attempt is made to "cover the field" of science; the discussion is limited to a few significant topics which are treated with some thoroughness. Basic mathematical concepts have been incorporated into the text as needed in the early chapters at an elementary level.

The text has been written in 2 independent sections: chemistry and physics in Chaps. 1-14, earth science (astronomy, meteorology, and geology) in Chaps. 15-33. Either section may be used first. The earth science section has been organized so that the astronomy, meteorology, and geology units may be taken in any order.--From pref.

Chaps. 24-33 deal with geology under the following headings: sermons in stones; crustal movements and geologic time; minerals and rocks; weathering, mass-wasting, and stream erosion; subsurface water; glaciation; volcanoes and related phenomena; rocks bend, break, and flow; Appalachian mountain geology; the fossil record.

2-1299. Fletcher, Gustav L., and Caleb Wroe Wolfe. EARTH SCIENCE: 4th ed., 556 p., illus., maps, secs., diags., tables, Boston, D.C. Heath and Company, 1959, refs.

This is the fourth edition of a high-school textbook. The first chapter gives a general idea of what has happened to the earth and what is going on now. The next 17 chapters comprise a study of the materials of the earth and of the forces acting on them. Some of the topics covered are: rocks and minerals, weathering, erosion, rivers, glaciers, and movements of the earth's crust, and a short geologic history of the earth. Also discussed: the earth in relation to other bodies in space, the seasons, latitude, longitude and time, phases of the moon, the solar system. Next the earth's atmosphere is studied, its temperature, pressure, movements, water content, and storms. Weather and climate, weather forecasting, and climates of the United States also receive attention. Then follows the study of the seas and seacoasts, the importance of the sea in trade, its action in shaping the land, and the characteristics of the seacoasts as related to their use. The final chapter deals with conservation of resources.--From pref.

2-1300. Simpson, George Gaylord. THE WORLD INTO WHICH DARWIN LED US: Science, v. 131, no. 3405, p. 966-974, Apr. 1, 1960.

The text of an address given at the annual meeting of the American Association for the Advancement of Science on Dec. 29, 1959. Professor Simpson deals primarily in the effect Darwin's work had on science, and his fellow scientists in his day, so setting the scene for present biological and paleontological thinking. Darwin's own personal feelings, on "creation" and evolution are traced through his books and letters, as well as the opinions of his contemporary biologists. The direct effect of the varying schools of thought on Darwinism, Lamarkism etc. have come to us very clearly, with the profound political implications that our society has built upon them.--B. C. Schreiber.

2-1301. Brennan, Louis A. NO STONE UNTURNED; AN ALMANAC OF NORTH AMERICAN PREHISTORY: 370 p., illus., map, New York, Random House, 1959, refs.

An attempt to trace the history of the human occupancy of North America over the past 40,000 years. This volume examines the impact of new discoveries and radiocarbon dating on the older theories concerning man's early history on our continent, then follows the various cultures down to the relatively recent Hopewell civilization.--M. W. Pangborn, Jr.

2-1302. Mason, Brian. TREASURES UNDERGROUND: 31 p., illus., New York, Home Library Press, 1960.

This is a brief, illustrated compendium, for ages 8 to 12, of the mineral commodities: coal, oil and gas, U, and the major metals and nonmetals, stressing their uses and occurrence in nature.--M. W. Pangborn, Jr.

**303. Haber, Francis C. THE AGE OF THE
RLD, MOSES TO DARWIN: 303 p., Baltimore,
n Hopkins Press, 1959, refs.**

This scholarly history traces the changes in man's
cept of the age of the earth, from Biblical times
he mid-19th century. After examining the Judeo-
istian 6,000-year scale of time, Haber shows how
pioneer studies of nature by da Vinci and other
ly scientists, and the overthrow of medieval cos-
logy by such astronomers as Copernicus and
no, eventually enabled early earth scientists like
fon, Werner, and Lamarck to work out progres-
ely more rational theories of the world's origin
age, culminating in the hypothesis of an evolved
rld of indefinite antiquity as conceived by Lyell and
win.--M. W. Pangborn, Jr.

**304. Howard, Arthur David. PHOTOGEOLOGY
STANFORD UNIVERSITY: Photogramm. Eng.,
26, no. 1, p. 72-73, March 1960.**

This brief article describes photogeologic facil-
s and instruction at Stanford University. Data
presented concerning laboratory space, photo-
logic equipment, aerial photographic coverage,
library facilities. Courses offered in photogram-
ry and photogeology are discussed in terms of
r basic goals and instructional methods.--J. R.
Lopik.

**305. Turpin, Robert D. SOME TRENDS IN
OTOGRAMMETRIC EDUCATION IN THE UNITED
ATES: Photogramm. Eng., v. 26, no. 1, p. 127-
, table, March 1960, 3 refs.**

In determining the status of photogrammetry and
to interpretation in the colleges and universities
he United States, the 1959-1960 Education Com-
tee of the American Society of Photogrammetry
xamined previous surveys and 2) collected some
ailed information from several U. S. universities
cerning the types of programs available to stu-
ts wishing to study photogrammetry - either as
ajor or as an adjunct to other fields. It is inter-
ing to note that prior to 1940 only a very few
ools offered any photogrammetry courses and
bably none required a photogrammetry course for
civil engineering degree. By 1957, 16 schools
re requiring a formal course in photogrammetry
the civil engineering degree, 48 were offering an
ctive course, and some 60 to 75 were offering
ne basic instruction in photogrammetry as part of
ourse described by some other name.

Questionnaires were sent to 9 schools selected on
basis of 1) classic interest in photogrammetric
dy, 2) representative size, and 3) location. Data
cerning 1) extent of course work and degree pro-
ms available, 2) staff and students currently
ive, and 3) equipment available for use in labora-
y and research work are tabulated for University
California, Cornell University, Georgia Institute
Technology, University of Illinois, Massachusetts
titute of Technology, Michigan State University,
o State University, Pennsylvania State University,
Syracuse University.--J. R. Van Lopik.

**306. Byerly, Perry. BENO GUTENBERG,
OPHYSICIST: Science, v. 131, no. 3405, p. 965-
, port., Apr. 1, 1960.**

A biographical sketch of the late Beno Gutenberg
89-1960), seismologist and geophysicist, tracing his academic life from 1911 until his death.--B. C. Schreiber.

2-1307. Nace, R. L. CONTRIBUTIONS OF GEOLOGY TO THE PROBLEM OF RADIOACTIVE WASTE DISPOSAL: 29 p., Washington, D.C., U.S. Geological Survey, [1959?], 50 refs.

This paper was presented on Nov. 21, 1959, to the Scientific Conference on the Disposal of Radioactive Wastes, Oceanographic Museum, Monaco, Nov. 16-21, 1959, sponsored by the International Atomic Energy Agency.

The earth is the sphere of interest of the geologist, and it is the only place on or in which wastes can be dispersed or stored. In that sense, problems of radioactive-waste disposal are primarily geological. Geologists as a group have been relatively slow to inform themselves about waste disposal problems or to apply their specialized knowledge to disposal problems. Nevertheless, a relatively few geologists have been active since the inception of the nuclear-energy industry. The U. S. Atomic Energy Commission has consistently recognized the important role of earth sciences and has steadfastly sought the aid and advice of earth scientists.

Accumulated geologic knowledge and established principles have been applied widely in the United States to problems of disposal, and the unique nature of these problems has led to research and significant advancements of knowledge in specialized aspects of geology.

A common activity has been appraisal of sites for nuclear-energy facilities. This includes analysis and evaluation of geologic, topographic, hydrologic, geochemical, and seismic factors. Site problems are classified in terms of the nature of wastes and their behavior in specific physical environments during the passage of time. Also, regional analyses are made of the gross characteristics of major physical subdivisions of the United States and the relation of these characteristics to waste storage and disposal.

Special studies include actual and potential behavior of intermediate - and low-level wastes in specific geologic environments such as volcanic, limestone, shale, and coarse-clastic terranes. Other studies concern possible use of structural basins, stratigraphic traps, and salt beds and salt domes for storage and containment of high-level waste.

Much general and some detailed study has been made of background radiometry, such as the radioactivity of natural waters and rocks, in order to provide a basis for identifying low-level contamination as a departure from background values and to clarify the geographic occurrence and geochemistry of natural radioelements.

Water is the critical factor in waste disposal because 1) water is the ubiquitous and universal solvent which dilutes and disperses released waste, and 2) water is a basic natural resource whose usefulness should not be impaired.

Certain natural processes by which water may be purified, or chemically altered have been investigated. Examples are ion exchange and adsorption, chemical precipitation, biological concentration, evaporation, diffusion, dispersion, turbulent mixing, and isotopic dilution. Significant results have been achieved in studies of dispersion and diffusion processes in ground water and surface water, the rate of travel of contaminants in streams, the mechanics of ground-water flow in granular materials, ground-water flow in cavernous rocks, and the behavior of water and chemical solutions in the zone of aeration.

Thermal and chemical-stability problems that would develop if high-level waste were injected in geologic formations also have been investigated. Geologic, petrologic, and geophysical studies have been made of specific areas, and research in clay mineralogy, ion exchange, and geochemistry has been aimed directly at waste disposal problems.--Auth.

2-1308. National Academy of Sciences-National Research Council, Committee on Oceanography. OCEANOGRAPHY 1960 TO 1970. 5. ARTIFICIAL RADIOACTIVITY IN THE MARINE ENVIRONMENT: 31 p., graph, Washington, D.C., 1959.

Consideration of the use of the sea for a sink for radioactive wastes has shown that we know far too little about physical, chemical and biological factors concerning their distribution after introduction. The Committee on Oceanography and the Committee on Effects of Atomic Radiation in Oceanography and Fisheries (National Academy of Sciences-National Research Council) recommend:

1) Specific legislation controlling disposal, under the U. S. Atomic Energy Commission.

2) Experimental studies of radioactivity dispersal in coastal waters under the U. S. Coast and Geodetic Survey or U. S. Public Health Service.

3) A research program on estuarine and coastal mixing and circulation with data collected and published immediately. The estimated cost of this program is $2,800,000, split evenly between the 2 environments.

4) An open ocean study of deep circulation, vertical exchange across the thermocline, and deep mixing, with $1,400,000 earmarked for this phase and with international collaboration.

5) Sedimentation studies including residence tim of elements in the ocean, and sea water-sediment element interchange, with an annual budget of $284,000 plus $200,000 to initially equip a laborator

6) A study of the effects of the biosphere on radi isotopes including productivity studies, zooplankton benthic populations, fish and marine mammal studi and ecological studies, at a total cost of $938,000 p year.

7) Investigation of genetic effects of radiation on marine organisms at $100,000 per year.

A second set of recommendations calls for field experiments including introduction of fission products into a lagoon ($100,000 per year), work on specific element concentrators, and radioisotope tracing of physical and biological processes. The latter includes tagging surface waters, dispersion at mid depth in the main thermocline, and tagging of bottom water. International collaboration is des able. The cost of a major offshore test would be $2,000,000.

A nuclear war would contaminate surface (and perhaps subsurface) waters, and yet large areas of the sea may be safer than the land, while fish may prove to be the main animal food still uncontaminate at least in the Southern Hemisphere. These matter should be studied.

The net cost of all programs above will be about $30,220,000 over 5 years, about one-third of which represents work now underway.--R. F. McAllister, Jr.

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